SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1919.

GENERAL PHYSICS.

500. *Maurer's Helio-Chronograph.* (Engineering, 107. p. 253, Feb. 21, 1919.)—This sunshine recorder is of the type in which a lens brings the sun's rays to a focus on a chart of blue paper placed on a rotating drum. The drum has also axial motion so that a helicoid curve is traced out. The frame which carries the lens is rotated by clockwork about the axis of the instrument, which is parallel to the earth's axis, so causing the lens to follow the sun throughout the day. The drum holding the chart turns once in two hours, giving a time scale of 120 mm. per hour. A shadow period of ½ minute can be detected. Adjustment for latitude is provided for in the design, and all other necessary adjustments can also readily be made.

J. S. Di.

501. *Determination of the Constants of Pyrgeometers.* **A. Ångström.** (Ark. för Mat., Astron. och Fysik, Stockholm, 13. No. 8. pp. 1–16, 1918.)—The pyrgeometer, an instrument for measuring nocturnal radiation, is constructed on the same principle as Ångström's pyrheliometer. The loss of heat from a pair of black radiating strips is made good by a compensating current i (amps.). The equation of the instrument is $R = C\, i^2 = \sigma(T_1^4 - T^4)$, where R is the outward radiation in gm. cals. per cm.² per min., σ Stefan's constant, T_1 the absolute temperature of the radiating strips in the instrument, and T that of the black body to which radiation takes place. The latter part of the equation is used for purposes of calibration for determination of C, the instrumental constant. A standard instrument was calibrated by K. Ångström at Upsala in 1906, and the constants of subsequent instruments have been determined by comparison with this standard. The original value found for the standard instrument was $C = 11{\cdot}5$. A later determination by Lindholm gave $C = 10{\cdot}0$. The present paper describes careful experiments to determine the true value of C for this instrument. It was found that the method previously adopted allowed convection currents to play upon the radiating and bright strips, greatly reducing the accuracy which could be obtained. In the calibrating apparatus here described this difficulty was overcome. The temperature of the radiating strips (T_1) and of the black surface to which radiation took place during the calibration (T) could be determined to within

0·1° C. During the measurements T was varied between -42° and -2° C. The result gave $C = 11{\cdot}65 \pm 0{\cdot}07$, and showed no dependence of C upon T. In the above the value of the constant in the Stefan-Boltzmann formula has been taken as $\sigma = 7{\cdot}68 \times 10^{-11}$. If Emden's value $7{\cdot}59 \times 10^{-11}$ is adopted as more accurate, $C = 11{\cdot}52 \pm 0{\cdot}07$. Thus K. Ångström's original determination is confirmed, while Lindholm's more recent one appears to be at fault. There is separate evidence that the constant has not changed appreciably with time. In taking readings with these instruments it is recommended that the strips be placed parallel to the wind. Errors arising from unequal convection are then practically eliminated. J. S. Di.

502. *Theory of the Pyrgeometer.* **R. Lundblad.** (Ark. för Mat., Astron. och Fysik, Stockholm, 13. No. 7. pp. 1–10, 1918.)—Considers the theory of the pyrgeometer taking into account the fact that the black strips are not perfect radiators nor the bright strips perfect reflectors, and other disturbing effects. An equation $C = f(c)$ is worked out connecting C, the constant of the instrument [see preceding Abs.] with c, the constant giving the heat produced in the black strips by the electric current (Heat $= ci^2$). In the simplest theory $C = c$. When all the disturbing factors are taken into account $f(c)$ becomes complicated, and is difficult to evaluate owing to ignorance of the numerical values of some of the terms. The theory suggests certain points which may be of importance in the working of the instrument. J. S. Di.

503. *New Planimeter.* **H. Kulka.** (Centralblatt d. Bauverwaltung, Berlin, 36. p. 549, 1916. Zeits. Instrumentenk. 39. pp. 30–33, Jan., 1919.)—Describes the construction of a new instrument for the determination of the surface area and of the static and inertia moments of a plane surface, *i.e.* for the mechanical evaluation (in rectangular co-ordinates x, y) of the integrals $\int y\,dx$, $\frac{1}{2}\int y^2 dx$ and $\frac{1}{3}\int y^3 dx$. For details the original paper should be consulted. A. W.

504. *Permanent Marking of Glass Vessels.* **J. C. Bock.** (Am. Chem. Soc., J. 41. pp. 359–361, March, 1919.)—The use of a glass colour, fused into the glass article by means of an ordinary burner, is described. The colours are intimately mixed with a vehicle made up of 4 parts of copaiba balsam, 1 part clove oil, and 1 part lavender oil, and then written with a pen on to the glass, after which they are burnt in by means of a Méker burner, care being taken not to deform the article. The colours most suitable are Green 728D, Blue 1079D, and a mixture of Brown 695D and White Enamel 1310D, as supplied by the Roessler and Hasslacher Chemical Co. A semi-permanent marking medium can be obtained by mixing a pigment (lead oxide, lamp-black, etc.) with a good spar varnish, Canada balsam, or collodion varnish. The author has marked test-tubes, pipettes, Kjeldahl flasks, beakers, distilling flasks, and microscope slides; also porcelain crucibles. T. S. P.

505. *Application of Wireless Telegraphy for Longitude Determinations.* **R. M. Stewart.** (Roy. Soc. Canada, Trans. 12. pp. 43–46, June–Sept., 1918.)—This paper gives a short description of the methods used by the Dominion Observatory for the determination of longitudes at stations not provided with a telegraph line. The Arlington time signals were used, and as these signals are controlled by a mean-time clock, it was not feasible to make a direct comparison with a sidereal chronometer by the method of coincidence of beats, since it would frequently happen that a coincidence would not occur during the five minutes for which the signals continue. It was therefore necessary to introduce an intermediate chronometer having a large rate. The chronometer used was rated to gain 15 minutes per day on mean time, giving a coincidence approximately every 96 secs. Three coincidences during the five minutes were thus assured, and not more than one of these could fall in the silent space at the end of the minute. To make the comparison a circuit derived from the chronometer, and including a suitable inductance, was led close to the cord attached to the head-piece of the receiving set, and when properly adjusted this caused a sharp click in the telephones on the opening of the chronometer circuit, while the subsequent closing was almost inaudible. The chronometer times of the coincidences having been noted, as well as the time (to the nearest half-second) of one or more Arlington even minutes, the comparison between Arlington and the chronometer is established; this is bridged over to the sidereal observing chronometer by a chronographic comparison before and after the receipt of the signals. A comparison is thus obtained, at a particular instant, between Arlington time and the observing clock at one station. If a similar comparison has been made at another station, the difference of time can be deduced by the two clocks, which completes the longitude "exchange." All the other operations incidental to a determination of longitude are carried on in the usual way. The deduced longitude does not depend at all on the correctness of the time signals used, so long as their rate is correct. The probable error of the complete comparison between the sidereal chronometers is from ± 0·01 sec. to ± 0·02 sec., and is of the same order as for an exchange by telegraph. A. W.

506. *Hardness Testing.* **A. F. Shore.** (Iron and Steel Inst., J. 98. pp. 59–78; Disc. and Corres., 79–88, 1918. Engineering, 106. pp. 444–447, Oct. 18, 1918).—A large number of experiments have been made to determine the relationship between scleroscope hardness and ball hardness under various loads. It was not found possible to obtain a satisfactory conversion curve under the 3000 kg. load. Above 550 Brinell, irregularities are caused by the flattening of the ball; below 550, discrepancies are brought about by the hardening which takes place. Pressures below 750 kg. were found to be insufficient for steel above 450 Brinell or 85 scleroscope. Accordingly a diamond sphere 10 mm. in diam. was employed, when it was found that pressures as low as 500 kg. gave consistent agreement with scleroscope readings even up to 800 Brinell. The relation between the scleroscope number and the pressure required to produce an impression 1 mm. in diam. using a 10-mm. ball on various materials was then found, and a regular curve was obtained for materials varying between tin and hardened steel. Quenched steel, 100 hard scleroscope, has a resistance to indentation of 700,000 lbs. per sq. in., whereas in the Brinell test, using a 3000-kg. load, a pressure of 1,000,000 lbs. per sq. in. is developed. Consequently the steel ball can only support this load by flattening out. Experiments showed that a previously flattened ball gave results from 100 to 150 Brinell lower than a new ball. A diamond, provided it has been carefully selected and that its cleavage planes are at right angles to the plane of the sample, can support a load of 1,250,000 to 2,000,000 lbs. per sq. in. It does not, however, lend itself to commercial application, because the indentations are so small that they can only be read under perfect laboratory conditions and because of the cost owing to breakage of diamonds. The diamond should be used on all materials whose hardness is over 80 scleroscope, but it is shown to be possible to provide the scleroscope with a Brinell scale. The constant-depth variable-load system can be applied with success to resilient organic materials like rubber. It is claimed that the scleroscope, using comparatively light pressures, measures a value closely associated with the elastic limit, while the Brinell test measures a value associated with the ultimate strength. To get really scientific comparisons, therefore, the load used on a 10-mm. ball in the Brinell test should be 750 kg., and certainly must not exceed 1000 kg. The paper concludes with a commentary by Hadfield and a note by J. J. Thomas on the relation between Brinell and scleroscope hardness.

F. C. A. H. L.

507. *Value of Clifford-Bessel Functions in Stability Problems.* **G. Greenhill.** (Engineering, 107. p. 334, March 14, 1919.) The complete solutions of problems such as the stability of beams, struts, and whirling shafts are given in the text-books in terms of Bessel functions. But the formulæ would be greatly simplified by the substitution of Clifford's function $C(x) = \Sigma\ (-x)^k/(\Pi k)^2$ [Math. Papers, p. 346], where k assumes all positive integral values and Πk is written for factorial k, which differ from the exponential function $e^{-x} = \Sigma\ (-x)^k/\Pi k$ in that while the latter never vanishes, $C(x) = 0$ has an infinite number of positive roots. The nth derivative and nth integral of $C(x)$ are, respectively, $C_n(x) = \Sigma(-x)^k/\Pi k\Pi(n+k)$ and $C_{-n}(x) = \Sigma(-x)^{n+k}/\Pi k\Pi(n+k)$, so that $C_{-n}(x) = x^n C_n(x)$. Therefore, (1) $d_x^{2n}x_nC_n(x) = C_n(x)$, and (2) $d_x[x^{n+1}\ d_xC_n(x)] = x^nC_n(x)$, or $xd^2C_n(x)/dx^2 + (n+1)\ dC_n(x)/dx - C_n(x) = 0$; and the C functions are related to the Bessel functions by the equations $J_n(2\sqrt{x}) = x^{-\frac{1}{2}n}C_{-n}(x) = x^{\frac{1}{2}n}C_n(x) = x^{\frac{1}{2}n}d^nC(x)/dx^n$, and $J_0(2\sqrt{x}) = C(x)$. The Bessel functions of real and imaginary argument are distinguished here by a mere change of sign in the argument x of the Clifford function, and the elaborate tables computed of the Bessel function, say of argument z, could be utilised by the mere addition of a new column alongside of $x = 2\sqrt{z}$, as argument x of the corresponding Clifford function. Where n is fractional, Clifford's Πn must be replaced by Gauss's $\Gamma(n+1)$. Examples are given, and it is suggested that if writers on questions of practical stability will introduce the practice of using Clifford's function in place of the Bessel functions, they will give to the writer of the theoretical text-book a lead he will be compelled to follow.

G. W. DE T.

508. *Torsion Cycles in Nickel Wires.* **T. Gnesotto** and **M. Binghinotto.** (N. Cimento, 16. pp. 19–34, July–Aug., 1918.)—A continuation of previous work [see Abs. 751 (1914) and 595 (1915)] on the Wiedemann phenomenon in Ni wires. Torsion cycles are given for the following conditions: (1) cyclic longitudinal magnetic field (H) constant current (i) in wire; (2) H constant, i cyclic; (3) cyclic current I to produce the field H, in phase with i, i/I being constant. In each group, experiments were made with (*a*) the limits of the variable of opposite signs, (*b*) one limit zero, (*c*) both limits of the same sign. **T. Gnesotto.** (*Ibid.* pp. 45–54, July–Aug., 1918.)—An extension of the above work to the case of a combination of two alternating currents and fields out of phase.

J. W. T. W.

509. *Bending of Beams of Uniform Section.* **K. Aichi.** (Phys. Math. Soc. Japan, Proc. 1. pp. 10–14, Feb., 1919.)—Gives formulæ for the shape of uniform beams variously loaded, the effect of the weight of the beam being taken into consideration. Beams of both rectangular and circular sections are considered.

J. W. T. W.

510. *Compressibility of Solids at High Pressures.* **L. H. Adams, E. D. Williamson, and J. Johnston.** (Am. Chem. Soc., J. 41. pp. 12–42, Jan., 1919.)—Describes a method for measuring the compressibilities of solids under hydrostatic pressures by comparing the change of volume under pressure, of a cylinder of the material with that of a similar cylinder of soft steel; the compressibility of the steel was taken as $0{\cdot}61 \times 10^{-6}$ cm.^{2}/megadyne at all pressures. The solid, surrounded by a liquid such as kerosene, was enclosed in a thick-walled steel bomb fitted with a movable leak-proof piston, and pairs of simultaneous readings were taken of the displacement of the piston and of the pressure. The piston displacement was measured to 0·01 mm. by means of a dial micrometer and the pressure was determined by observing the change of resistance of a "therlo" wire. The results are given for 16 materials at pressures up to 12,000 megabars. The (pressure)–(volume change) curve for Au, Cu, brass, Ag, Al, and calcite, like that of steel is sensibly linear, but that for Zn, Sn, Cd, Pb, quartz, Bi, and NaCl shows an appreciable curvature, thus indicating a sensible decrease of compressibility with increasing pressure. For alloys of the class of a simple mixture, such as a Sn-Bi alloy, the compressibility is an approximately linear function of the compressibilities of the two components. For alloys of the class to which brass belongs, however, the compressibility of the alloy is much lower than the sum of the individual compressibilities of the components. J. W. T. W.

511. *Elasticity Limits.* **O. Lehmann.** (Deutsch. Phys. Gesell., Verh. 20. pp. 63–68, April 30, 1918.)—A discussion of the subject from the molecular point of view. E. H. B.

512. *Internal Molecular Forces in Solids.* **S. Pagliani.** (N. Cimento, 15. pp. 103–129, March–April, 1918.)—Breaks these up into three: (1) intermolecular force of cohesion, resisting changes at constant volume; (2) internal pressure, analogous to external pressure, resisting changes which involve a change of volume; (3) intermolecular force resisting changes of phase. The values of (1) present interesting relations to the elastic constants of solids, the coefficients of elasticity for example being directly proportional to (1); and (3) bears similar relations to the thermal constants. A. D.

513. *Gyroscopic Force of Fluids.* **E. Faure.** (Comptes Rendus, 168. pp. 395–398, Feb. 24, 1919.)—Mathematical treatment of the application of gyroscopic ideas to electromagnetic theory. E. H. B.

514. *Variation of Period of Balance Wheel due to Elastic Bending.* **H. Blasius.** (Zeits. Instrumentenk. 39. pp. 19–27, Jan., 1919.)—In this paper the author obtains formulæ giving the amount of variation of the period of oscillation of a balance wheel due to its elasticity. A. W.

515. *Motion of Simple Pendulum after String is Slack.* **W. B. Morton.** (Phil. Mag. 37. pp. 280–284, March, 1919.)—Works out the parabola followed by the bob of a simple pendulum after the string has become slack. A graph is also given exhibiting the relations of the variables in question for various cases. E. H. B.

516. *Disappearance of Smoke in a Confined Space.* **R. C. Tolman, E. B. Vliet, W. McG. Peirce** and **R. H. Dougherty.** (Am. Chem. Soc., J. 41. pp. 304–312, March, 1919.)—When a smoke is set up in a confined space it gradually disappears, owing to coagulation, to settling, and to the diffusion of the particles to the walls where they stick. In the experiments described the rate of disappearance of smokes in a metre-cube box was followed by the Tyndallmeter [see Abs. 566 and 567 (1919)]. E. H. B.

517. *Researches on Gravitation.* **V. Crémieu.** (Comptes Rendus, 168. pp. 227–230, Jan. 27, 1919.)—Following up work already published [see Abs. 131, 132 (1918)] the author describes several experiments to test the effect on the electromagnetic field of the rotation of a cylinder of lead (50 kg.) at a speed of 20 revs. per sec. (1) The electric field between the cylinder and a fixed electrode is not modified to 1/100,000 by the rotation. (2) The Hertzian field in the region of the rotating cylinder is not apparently affected. (3) The plane of polarisation in connection with two crossed nicols is not influenced perceptibly. P. E. S.

518. *Waves from Broken Dams.* **A. Schoklitsch.** (Akad. Wiss. Wien, Ber. 126. 2a. 10. pp. 1489–1514, 1917.)—In view of the more intensive utilisation of water power, it is important to consider what overflow may be expected from a broken dam or weir and how this overflow is propagated from the fracture. The author reviews earlier calculations and experiments; describes his own experiments; considers the contour and velocity of the flood, and the evacuation of the storage basin; and cites hypothetical and actual examples. Some of the author's experiments were conducted in smooth wooden troughs 0·096 m. to 0·6 m. wide, 0·08 m. to 0·25 m. deep, and up to 26 m. long; other tests were made in the open in trenches 1·3 × 1 m. × 150 m. long. In each case a plate was used as dam, this being raised as quickly as possible and observations being then taken of the depth of the flood at various stations. In order to imitate partial failure of a dam, the opening uncovered by the removable plate was made rectangular and for the whole or part depth of the dam, and also V-shaped. The water depth at the dam remained constant for some time, but its actual value depended considerably on the relative width of the breach. Formulæ are given for the water-level at the opening and for the volumetric outflow per sec. If the whole dam be removed, the level at that point falls to one-half the original. If the whole of the upper portion of a dam of height H be removed down to a height z, the level falls to approximately $\frac{1}{2}(H-z)$; *i.e.* the case is practically that of complete failure of a dam of height $(H-z)$, but the initial outflow is greater than it would be with this height. The discharge (m.^{3}/sec.) varies with $(H-z)$. When only part of the width of the dam fails, the discharge is greater if the breach be central than if the breach be at one side.

The surface of the flood is a very slight curve concave downwards and connected to the level in a storage pond through a change-point at the site of the dam. The front of the wave is rounded if the stream be deep below the dam, but it is broken if the water be shallow. The form of the wave in small earth channels is very much affected by the roughness of the bed. Formulæ are given for the level of water at the breach under various circumstances; and the effect of the gradient of the bed on the velocity and volume of outflow is considered. R. E. N.

519. *On the Flow of Gases at very High Pressures.* **A. Rateau.** (Comptes Rendus, 168. pp. 330–335, Feb. 17, and pp. 435–439, March 3, 1919.)—The classical formulæ for the flow of gases through pipes are based on the assumption that the gases are perfect. They are no longer correct when the initial pressure is very high, *e.g.* several hundred atmospheres, as in the case of artillery. In such cases the co-volume a has to be taken into account, and the object of the present paper is to discover the modifications necessary for the formulæ to be more in accord with practice. If the gas flows from a reservoir, where the initial data are p_0 (pressure), u_0 (specific volume), ϵ_0 (the relative co-volume which is an expression for $a/(u-a)$), T_0 (temperature) and if the pressure pipe (which may be converging) has S_c for its smallest cross-section, then the delivery I at any cross-section S where the data are p, u, ϵ, and T is given by

$$\left(\frac{I}{S}\right)^2 = \frac{2gp_0}{k(u_0-a)} \cdot \frac{x^{2(1-k)}[1-x^k+\epsilon_0 k(1-x)]}{(1+\epsilon_0 x^{1-k})^2},$$

where $p/p_0 = x$ and $k = (\gamma-1)/\gamma$, γ being the ratio of the gaseous specific heats. For artillery the temperature is in the region of 1600° C., and γ is about 1·25, according to the results of Mallard and le Chatelier. In the above expression, the first term of the second member only depends on the initial conditions in the reservoir, while the second term varies with x, that is, with the pressure in the pipe section considered. At the neck of the pipe the co-volume is found to reduce the pressure by about $\frac{1}{4}\epsilon_0$. The speed W_c is given by the expression $W_c = \sqrt{(g\gamma p_c u_c)}(1+\epsilon_c/2-\epsilon_c^2/8)$. H. H. Ho.

520. *Wave Resistance in Special Cases of Three-dimensional Fluid Motion.* **T. H. Havelock.** (Roy. Soc. Proc. 95. pp. 354–365, March 15, 1919.)—Wave resistance, corresponding to a pressure system travelling over the surface, has hitherto been calculated only for two-dimensional fluid motion, so that the surface distribution of pressure is one-dimensional, and the regular waves produced have straight parallel crests. The author here obtains solutions in some cases when the surface pressure is two-dimensional and the wave pattern is of the type due to the motion of a ship. He first considers a pressure system symmetrical about a point, and obtains more general distributions by superposition. Interesting interference effects are shown when two simple systems of equal magnitude, one in rear of the other, are combined. The author points out that in similar calculations with line pressure systems, at certain speeds the waves due to one system cancel out those due to the other, giving zero wave resistance. The corresponding ideal ship model has been called a *wave-free pontoon*. Such cases of perfect interference do not occur in three-dimensional problems; the graph showing the variation of wave resistance with velocity has the humps and hollows which are characteristic of ship-model resistance curves. The author shows how some of his results may be interpreted in terms of a submerged body, the waves produced by a travelling surface pressure being, with certain limitations, such as would be caused by a submerged body of suitable form, and that the analysis here given confirms the expression given in a former paper, for the wave resistance of a submerged sphere [Abs. 1338 (1917)]. He also shows how the method may be extended to the case of a submerged body whose form is derived from stream-lines being obtained by combining sources and sinks with a uniform stream, and as an example, an expression is given for the wave resistance of a prolate spheroid moving in the direction of its axis of revolution. G. W. DE T.

521. *Random Vibrations and Random Flights in One, Two, or Three Dimensions.* **Rayleigh.** (Phil. Mag. 37. pp. 321–347, April, 1919.)—When a number (n) of isoperiodic vibrations of unit amplitude are combined, the resultant depends upon the values assigned to the individual phases. When

the phases are at random, the resultant amplitude is indeterminate, and all that can be said relates to the *probability* of various amplitudes (r), or, more strictly, to the probability that the amplitude lies within the limits r and $r + dr$. The important case where n is very great was considered by the author in 1880 (Scientific Papers, vol. i. p. 491), with the conclusion that the probability in question is simply $\frac{2}{n}e^{-r^2/n}rdr$. The phase (θ) of the resultant is, of course, indeterminate, and all values are equally probable.

The "problem of the random walk" was formulated in 1905 as follows. A man starts from a point 0 and walks l yards in a straight line; he then turns through any angle whatever and walks another l yards in a second straight line. He repeats this process n times. Required the probability that after these n stretches he is at a distance between r and $r + dr$ from his starting-point 0. The present author pointed out (Scientific Papers, vol. v. p. 256) that this question is mathematically identical with that of equal vibrations with phases at random.

The problems in one, two, and three dimensions are then treated mathematically, and a number of forms of solution given, some being exact and others approximate but suitable to special cases. His analysis involves the work of Todhunter, Pearson, J. C. Kluyver, G. T. Bennett and others, and is difficult to abstract without reproduction of diagrams and tables. E. H. B.

522. *Measurement of Capillary Constants of Viscous Liquids by Means of Interference Fringes.* **H. Nisi.** (Phys.-Math. Soc. Japan, Proc. 1. (Ser. 3.) pp. 40–42, March, 1919.)—Describes the preliminary results on the measurement of the capillary constants of some viscous fluids, using interference fringes to determine the form of the free surface, the capillary constants being derived from the deformation of the surface. The arrangement was essentially the same as Fizeau's dilatometer as improved by Abbe and Pulfrich, except that the observing telescope was replaced by a small camera to which an eyepiece was attached for visual observation. Values were obtained for the surface tension of paraffin oil and glycerine which agree with determinations by other methods. A. W.

523. *Energy Exchange by Collision.* **G. Hertz.** (Deutsch. Phys. Gesell., Verh. 19. pp. 268–288, Nov. 30, 1917.)—The collisions considered are those between slow-moving electrons and gas molecules. The laws for the motion of electrons in an electric field, in gases of small electron affinity, are developed. Measurements of the limiting velocity which electrons in helium acquire in an electric field allow the energy loss for a single collision between an electron and a helium atom to be calculated. The energy loss is $2{\cdot}7 \times 10^{-4}$ of the energy of the electron. From the agreement of this result with the value $2{\cdot}9 \times 10^{-4}$, which is the value of the energy loss obtained if the collision between an electron and a helium atom takes place according to the laws of impact of elastic spheres, it follows that the whole loss of energy from the electron will appear as kinetic energy of the helium atom. For hydrogen the results only give the order of magnitude of the energy loss, which is about 6×10^{-2} of that of the colliding electron. Hence, in the case of collision between an electron and a hydrogen molecule there is an energy transfer to the internal degrees of freedom of the hydrogen molecule. Theory is also given relative to the motion of free electrons in gases at high pressure, and the great effect of very small amounts of impurities is found to be in quantitative agreement with the theory developed. A. W.

524. *Oscillation Method for measuring Ultramicroscopic Particles.* **P. V. Wells** and **R. H. Gerke.** (Am. Chem. Soc., J. 41. pp. 812–829, March, 1919.) —A method is here presented for measuring the size of ultramicroscopic particles by their oscillation amplitudes in an electric field which is reversed by a rotating commutator. This eliminates the uncertainties in previous methods due to the effects of Brownian motion and to passing out of focus. Moreover, it renders possible the precise determination of the Stokes' law size of a single particle. E. H. B.

525. *Atom-Structure on the Basis of X-ray Spectra.* **L. Vegard.** (Kristiania Vid. Selsk. Oct. 30, 1917. Deutsch. Phys. Gesell., Verh. 19. pp. 344–353, Dec. 30, 1917.)—Observations on the number of electrons in the "rings" surrounding the nucleus of atoms. Tables are given showing the arrangement of all the known elements with the corresponding electron-systems.

The scheme has its basis on Bohr's theory of atom structure. A. B. W.

526. *On the Calculation of Absolute Crystal Dimensions.* **M. Born.** (Deutsch. Phys. Gesell., Verh. 20. pp. 224–229, Dec. 30, 1918.)—The author here discusses an apparent difficulty which arises when Bohr's atomic models of electronic ring systems are used for the construction of crystal lattices. For simplicity he takes a one-dimensional crystal composed of a periodic series of two kinds of mass points arranged equidistantly in a straight line. It is then evident that for every effect which one point experiences from one of the others, there is entailed an oppositely directed effect from the symmetrically situated point. The end points, however, of a finite series are under special conditions, and while the statement of the force-law between any two points will not determine the absolute dimension of such a point series, yet the boundary condition may lead to the desired result. The same conditions prevail for a three-dimensional lattice arranged as in the NaCl type. It would appear, therefore, at first sight impossible to calculate the absolute lattice constant from the atomic forces unless the edge conditions are known ; this view, however, brings up the question of why the density of the crystal is practically independent of the condition of its surface. In reality the above difficulty is now shown to be only apparent. For the case of regular crystals of the type of NaCl, Landé and Born have already shown that an equation of condition for the lattice constant δ can be obtained without reference to the boundary, namely, the potential energy Φ for all atoms of the crystal upon the atoms of an inner cube element, which was found to be a function of δ. The total energy of a crystal consisting of N cube-elements is therefore $\frac{1}{2}N\Phi(\delta)$, and for equilibrium this expression must be a minimum, that is $\Phi(\delta) = 0$. Consequently δ may be calculated. The mathematical investigation of these conditions forms the substance of the paper.
H. H. Ho.

527. *The Crystal Lattice and Bohr's Atomic Model.* **M. Born** and **A. Landé.** (Deutsch. Phys. Gesell., Verh. 20. pp. 202–209, Dec. 30, 1918.)—In a recent publication by these authors [see Abs. 300 (1919)] the attempt was made to conceive some regular crystals of the NaCl type as aggregates of Bohr atomic models, and to calculate the absolute magnitude of their lattice-spaces as universal constants and whole numbers (atomic numbers, valency values, etc.). A positive alkali ion, and a negative halogen ion, composed of positive nuclei and electronic rings, act at a distance upon each other as though their charges were at the centres and with electrostatic Coulomb potential inversely proportional to their distance r apart. In close vicinity, however, the potential is modified to an expression $P = r^{-1}\psi^{-1} + r^{-3}\psi^{-3} + r^{-5}\psi^{-5} + \ldots$, where P is the total potential of two such ring systems, and ψ a coefficient which depends on the radii and the spacial orientation of the electronic rings. For the crystal union, where every ion is assumed to be under the influence of an infinite number of other ions, an equilibrium position is assumed wherein the electronic rings are all concentric and coplanar, and the axes of these coplanar ring systems are alternately in the direction of the four long chief diagonals of the cube-element in the cubic lattice. In the previous publication the idea was suggested that the third electronic ring of chlorine and potassium may be triquantic, but further experience has shown the untenability of this proposition. Better agreement was found by assuming a diquantic outer ring and the electrons of the inner ring to be provided with two quanta. The assumption is now made that the first ring is monoquantic, and that all succeeding rings are diquantic. Tables of results are given which are in good accord with theory. The concluding remark made is to the effect that the calculation of the elastic compressibility of the halogen alkali salts leads to theoretical values which are roughly twice those measured. This forms the subject-matter of the next paper. H. H. Ho.

528. *Calculation of the Compressibility of Regular Crystals from the Lattice Theory.* **M. Born** and **A. Landé.** (Deutsch. Phys. Gesell., Verh. 20. pp. 210–216, Dec. 30, 1918.)—Having shown that the lattice constants of regular crystals of the type of NaCl may be calculated, if the atoms be conceived as Bohr electronic ring systems with definite axial directions [see Abs. 300 (1919) and preceding Abs.], the authors now proceed to derive the remaining properties of crystals from this structural conception. One of the simplest is the calculation of compressibility, and this has been found to be double the observed value. Crystals constructed from Bohr's atoms are apparently too yielding. This result is remarkable, inasmuch as no special assumptions have been made with respect to the electronic ring of the atom, but a general law obtained for the repulsion of the ring to the effect that the potential energy of this repulsion is inversely proportional to the fifth power of the lattice constant δ. It has been shown that the potential energy per cube-element has the form $\phi = -a/\delta + b/\delta^5$, where the first term represents the electrostatic (Coulomb) attraction of the atomic charges concentrated at their middle point, and the second term the repulsion effect of the electronic ring. In order to explain the above discrepancy the authors start from the general expression $\phi = -a/\delta + b/\delta^n$, and prove that the value $n = 5$ is incompatible with the observed compressibilities and must be replaced by $n = 9$. A table of results is given for the halogen salts NaCl, NaBr, NaI, KCl, KBr, KI, TlCl, TlBr, and TlI. The authors conclude that the application of Bohr's atomic models for the explanation of crystal properties has been justified. The three principal results are as follows:—(1) The determination of the crystal lattice. (2) The atoms carry a number of charges $e = 4{\cdot}76 \times 10^{-10}$ corresponding to their valency. (3) In addition to a contraction effect due to the charges of $-a\delta^{-1}$, there also exists an expansion effect $b\delta^n$, and no other essential force. The value $n = 9$, appears to indicate that the atomic structures are spacial, and that plane electronic orbits are insufficient. H. H. Ho.

529. *Electrostatic Potential of the Fluorspar Lattice.* **A. Landé.** (Deutsch. Phys. Gesell., Verh. 20. pp. 217–223, Dec. 30, 1918.)—The properties of poly-

atomic crystals are essentially conditioned by the electrostatic potential of the ionic points. In this connection the theory of compressibility [see preceding Abs.] affords a means of calculating the potential of the cubic lattice for crystals of the NaCl type. The present paper is an extension of the former investigation to more complicated members of the regular system, *e.g.* fluorspar, CaF_2. The space-lattice of fluorspar is built up of double-charged Ca ions (++) and single-charged F ions (—) as follows:—The (++) are situated in the cube corners and the middle points of the sides of a cubic lattice, and the (—) upon the four long diagonals and distant about a quarter-length from the corners. If for unit length the distance be taken from a (++) to the nearest (—), then the cube-element δ^3 has an edge $\delta = 4/\sqrt{3}$ and contains 4 (++) ions and 8 (—) ions. In order to obtain the electrostatic potential Φ of all the crystal ions at the twelve ions of a cube-element, the potential need only be calculated at any triplet (—)(++)(—1) and multiplied by 4: $\Phi = (\overset{++}{\varphi} + 2\overset{-}{\varphi})$. According to Madelung's method [Abs. 327 (1919)] $\overset{++}{\phi} + 2\overset{-}{\phi}$ is made up of 3 parts, namely, point, line, and plane potentials, and these are separately calculated in the paper. Assembling the results, the potential of all three ions (—), (++), (—1), for the charges $(++) = 2$, $(-) = -1$, has the value $\overset{++}{\varphi} + 2\overset{-}{\phi} = -6{\cdot}931 - 1{\cdot}605 + 0{\cdot}1674 = -8{\cdot}369$. For the charges $(++) = 2e$ and $(-) = -e$, the potential for the four sets of three ions of the element cube is $-8{\cdot}369 \, . \, \frac{1}{\delta} \, . \, \frac{4}{\sqrt{3}} \, . \, 4e^2$, which equals $-77{\cdot}31e^2/\delta$. From this result the author concludes that the ions can be treated as point charges. H. H. Ho.

530. *On Cubic Atomic Models.* **M. Born.** (Deutsch. Phys. Gesell., Verh. 20. pp. 230–239, Dec. 30, 1918.)—Section 1 of the paper deals with the cubic hypothesis. After a brief reference to Sommerfeld's work, the author points out that the Bohr ring system is insufficient for the elucidation of many important atomic properties. An essential drawback is that the single electronic ring possesses axial symmetry, whereas real atoms appear from many observed characteristics to have spacial symmetry of quite another species. From an investigation as to whether a simple regular crystal lattice such as NaCl could be constructed from Bohr ring systems, it has been shown [see Abs. 300 (1919)] that while the lattice constants are approximately correct, the compressibilities are much too great. This result appears so important that the author concludes a structure built of plane rings to be impossible. In consequence he has sought to find suitable alterations whereby the fundamental truth of Bohr's theory may be preserved. These considerations have been restricted to the inert gases and to the ions of the alkali metals and halogens which form a crystal lattice of the type NaCl. According to Kossel (Abs. 641 (1916)] the alkali atom after parting with an electron should have an outer shell of 8 electrons, while the halogen atom should be similarly placed after acceptance of an electron; also the inert gases possess their especially great stability on account of their 8 outer electrons. This number 8 suggests the view that the electrons of the inert gases and of the alkalies and halogens are arranged at the corners of a cube, or at least describe orbits having cubic symmetry. Accordingly the author brings forward every empirical argument in support of this cubic hypothesis. First he considers the periodic system of the elements in which the two first periods have the length 8, which constitutes the main reason why Kossel

ascribes an outer shell of 8 electrons to the stable atoms of the inert gases. Should the atoms be constructed as a plane ring system, then no special ground exists for the number 8 to have stability significance, but if the electrons describe spacial orbits then the cube of 8 electrons becomes important. Similarly the author discusses the fact that the properties of the carbon atom can only be explained on a tetrahedron structure, from which he concludes oxygen to be represented by an octahedron and argon by a cube. Following this comes a discussion of the regular crystal system the members of which have the same lattice as NaCl, from which the author concludes that the force-effect of the atoms is chiefly conditioned by its outer shell of 8 electrons, which must rotate in an orbit of cubic symmetry. Detailed reference is then made to the compressibility property, which again can only be explained on a spacial arrangement. Having established the cubic hypothesis to his own satisfaction, the author next proceeds to construct a corresponding atomic model according to Bohr's fundamental hypothesis. Section 2 of the paper then investigates the interaction between two electronic cubes.

The paper is mathematical throughout. H. H. Ho.

531. *Electronic Orbits in Polyhedric Union.* **A. Landé.** (Preuss. Akad. Wiss. Berlin, Ber. 5. pp. 101–106, 1919.)—The paper commences with a reference to the evidence in favour of the atoms having a spacial polyhedric symmetry instead of a superficial ring system, namely, the tetrahedral structure of the carbon atom necessitated for the explanation of optical activity, and the properties of the crystal lattice [see Abs. 300 (1919)]. For evolving a spacial theory of the atom, the established methods for obtaining the dynamical equilibrium satisfying quanta conditions are employed. The general problem is that of n bodies of n electrons rotating about a nucleus; when $n=8$, the interaction of the eight electronic orbits must produce a cubic structure according to Born, *i.e.* to every fragment of orbit correspond 47 further fragments. A similar solution can be obtained for the orbits of four electrons, with respect to the tetrahedron. For the general case of polyhedric union, special relations must be obtained for the n bodies between the $3n$ coordinates analogous to the simple cases where the electrons at equal intervals apart describe circles of constant radius, or follow the Sommerfeld ellipse hypothesis, in which the electrons always form a regular polygon of periodically changing diameter. Section 1 of the paper investigates the case of four electrons in tetrahedric union, section 2 deals with eight electrons in cubic union, while section 3 considers a variety of periodic orbits.

The paper is mathematical throughout. H. H. Ho.

532. *Ether Hypothesis.* **G. Borelius.** (Deutsch. Phys. Gesell., Verh. 20. pp. 250–252, Dec. 30, 1918.)—The author assumes the following constants :—

$c = 2{\cdot}999 \times 10^{10}$ cm./sec., speed of light.
$e = 4{\cdot}774 \times 10^{-10}$ E.S.U., electron charge.
$h = 6{\cdot}547 \times 10^{-27}$ erg sec., Planck's action element.
$m = 0{\cdot}902 \times 10^{-27}$ gm., electron mass.
$M = 1{\cdot}662 \times 10^{-24}$ gm., hydrogen-atom mass.

The ether is then thought of as a simple cubical crystal space-lattice, for whose "building stones" or ether atoms the name *etheron* is used. In the cubic centimetre there are $N = 1 : a^3$ etherons, where a gives their distance.

This lattice is supposed full of zero-point radiation, to each vibration of which corresponds the energy $h\nu$, where ν is frequency. Proceeding on the laws for such lattices given by Debye and Born and v. Karman, the author finds for the ratio M/m the value 1804 whereas $1662 \div 0 \cdot 902 = 1843$. [See Abs. 185 (1918).] E. H. B.

533. *The Hamilton-Jacobian Function and the Quanta Theory.* **P. S. Epstein.** (Deutsch. Phys. Gesell., Verh. 19. pp. 116–129, July 30, 1917.)—Recently Einstein has given a new formulation of the quanta rules [see Abs. 654 (1917)], which is based on the singularities and ramifications of the Jacobian function. The further extension of this mode of investigation may perhaps afford the means of elucidating the problem of conditional periodic motions and also of treating more generalised systems. In the present communication the author shows that in the expression for conditional periodic motions, certain difficulties arise with Einstein's theory which have to be surmounted. These appear in the dependence upon the constants, since to every value system of the latter there corresponds an individual orbit, and the problem of the quanta theory is to choose the static orbit from the possible ones which arise. In section 2 of the paper it is shown from general considerations, which are illustrated by examples in section 3, that, in the retention of an individual orbit, new singularities of quite a different analytical character are introduced, and the old ones may disappear, solely by transformation of the constants. The application of the quanta rules before and after the transformation thus furnishes different static orbits. In consequence it appeared of importance to the author to investigate whether the above result was an exceptional case or a general characteristic of the Jacobian function. Accordingly section 4 is devoted to those mechanical systems which are similar to the above in the execution of libration motions by one section of the variables. These are manifested in the fact that the variables are separable. For such systems a hypothesis has been evolved which is a generalisation of a previous expression given by the author for completely separable systems. H. H. Ho.

534. *Does the Relativity Theory Exclude the Reality of Space and Time?* **J. Petzoldt.** (Deutsch. Phys. Gesell., Verh. 20. pp. 189–201, Dec. 30, 1918.)—This paper is a philosophical inquiry into the reality or non-reality of space and time from the special standpoint of the relativity theory. Stated briefly, the problem is to determine whether space and time are to be regarded as sensations in like manner to colour, or whether they must be accepted as *a priori* forms of sensation. Now although the relativity theory has not originated from the transcendental idealism of Kant but from the relativity positivism of Mach, yet the majority of theoretical physicists have regarded this theory as affording a proof of the ideality of space and time, and of the universe as a presentation. A recent adherent to this view is to be found from Sommerfeld's statement that Einstein might have surmounted the difficulties of optics and mechanics by the denial of reality to space and time. The present author not only holds the opinion that Einstein could not accept such a mode of removing difficulties, but that Sommerfeld's view has never been a logical consequence of the relativity hypothesis. The paper is throughout a philosophical argument to show the untenability of Sommerfeld's hypothesis. The authorities quoted include Kant, E. Du Bois Reymond, Spinoza, Leibnitz, Minkowski, Cohn, Locke, Berkeley, R. Mayer, Galileo, and Hertz. Spaces and times according to the relativity theory are

shown to be not approximations to real space and time experiences, but ideas from which these experiences have been clearly represented. If, according to the author, Sommerfeld had limited his assertion to this picture of the theory, then it would have been seen that the relativity theory was not the first to forbid space and time being regarded as realities, but that it had already been indicated by positive mathematics and natural science. Since, however, Sommerfeld generalised his assertion, the present author has supplied this correction. H. H. Ho.

535. *Relativity Analysis.* **A. D. Fokker.** (K. Akad. Amsterdam, Proc. 21. 4. pp. 505–517, 1919.)—This is an account, taken from a paper on *Direct Relativity Analysis* communicated by J. A. Schouten to the Amsterdam Mathematical Society, and offered for publication in the Amsterdam Proceedings, of methods precisely defining geodesic displacement and the geodesic differential of a vector in a space of finite curvature of any dimensions. The original paper should be consulted. G. W. DE T.

536. *Anomalies of the Winds at Skudesness, Norway,* **G. Guilbert.** (Comptes Rendus, 168. pp. 460–461, March 3, 1919.)—Of all the European Meteorological Stations which report daily by telegraph for the purpose of weather forecasts, only one, Skudesness, does not obey the ordinary laws of the relation of winds to isobars. The station is at sea-level in the southwest of Norway at the head of the Stavangar Gulf. Only winds from south and east at Skudesness, however, do not conform with the laws.

The author states that these divergencies frequently form the first indications of the approach of a storm towards Europe from the Atlantic. [The abnormal winds at Skudesness are commonly ascribed to the local configuration and relief of land and sea.] R. C.

537. *Effect of Uncertainties of Hours of Observation upon the Study of Line-Squalls.* **J. Renaud.** (Comptes Rendus, 168. pp. 410–411, Feb. 24, 1919.)—Changes from Greenwich to "Summer" time and conversely are responsible for numerous uncertainties as to the exact times of occurrence of changes of pressure, temperature, and humidity as recorded on autographic instruments. This increases considerably the difficulty of the subsequent study of phenomena like line-squalls. A system of notation for time is required which leaves no room for doubt as to the standard of time adopted. R. C.

538. *On Land- and Sea-Breezes at Bayonne.* **Rouch.** (Comptes Rendus, 168. pp. 313–315, Feb. 10, 1919.)—Land- and sea-breezes in summer at Bayonne are investigated by forming hourly means of velocity and direction for the fine days of the summer of 1918. These show that the land breeze is pronounced from midnight to 10h., the sea-breeze from 13h. to 19h. The two remaining periods of the day are transition periods with light indefinite winds. The breezes do not blow exactly at right angles to the direction of the local coast line, but show the influence of the large land mass of the Spanish peninsula to the south. The sea-breeze reaches a velocity of 3 m./sec., whereas the land-breeze does not exceed 1·9 m./sec., the difference being due to the increased resistance offered by the land to the motion of the air. Land- and sea-breezes extend to altitudes of 400 m. without much change, but beyond that height land-breezes gradually back and sea-breezes veer until at 1000 m. the distinction between the two has disappeared, the wind blowing from east at that level. R. C.

539. *Seiches, Lake Kutcharo.* (Tôhoku Univ., Sci. Reports, 7. pp. 197–208, Dec., 1918.)—Preliminary experiments with a model followed by observations on the lake, show the existence of two surface seiches of equal amplitude; and two internal seiches, one binodal, whose amplitudes are in the ratio of 1 : 2. Observations on changes of level due to the wind are also given, and the paper is abundantly illustrated with curves. W. A. R.

540. *The Horizontal Component of Instantaneous Terrestrial Motion.* **G. Gianfranceschi.** (N. Cimento, 15. pp. 221–248, May–June, 1918.)—A study of the curves necessary to represent for any latitude, and for any hour of the day and year, the absolute direction in space of the horizontal travel of the earth's surface under (1) the terrestrial rotation, (2) the revolution of the earth round the sun, and (3) the travel of the solar system in space. A. D.

541. *Origin of the Earth.* **E. Belot.** (Observatory, No. 537. pp. 127–131, March, 1919.)—The earth and four satellites, of which the moon is the outermost, were generated by the impact of a cylindrical gaseous vortex with a nebula through which the system gradually passes, the relative motion being equivalent to a rapid translation of the earth in a South–North direction. The present form of the earth and the disposition of its surface features are deduced from this conception. Three stages of development are recognized: (1) the nebulous; (2) the igneous—ceasing when the critical temperature of water is reached; (3) the diluvial or geological period. The earliest atmosphere of all-volatile constituents would be driven by friction with the nebula to the S. Pole, and, when the critical temperature of water was reached, a deluge in the antarctic would result and inaugurate a period of powerful denudation. The author considers that the three great periods of mountain-building and earth movement were caused by the fall of the three inner satellites. W. A. R.

542. *Periods of Seiches in Long Lakes.* **H. Jeffreys.** (Observatory, No. 537. p. 128, March, 1919.)—In oscillations of the water in long lakes the longitudinal displacement of a particle satisfies a certain differential equation. Similar equations are satisfied by the displacement of a stretched wire of variable thickness fixed at the ends and bowed in the middle, and by the velocity potential in an organ-pipe open at both ends and of variable section. Thus the solution of any one of these problems can be found from the solution of either of the others, provided only that the forms of the lake, the wire, and the pipe corresponded in such a way as to give the same differential equation. The use of an organ-pipe for this purpose is suggested; three of the sides of a rectangular pipe could be permanent, the fourth being made of a form to suit the lake under consideration, and fixed to the other three by some airtight plaster until the determination is made. Such a method is suggested as being of much use in finding the periods of seiches; for it would give a solution as accurate as the survey, whereas the usual method of assuming the nearest parabola as the form of the bottom is at best a very rough approximation. E. H. B.

543. *Deviations of Optical Axis of Meridian Telescope.* **M. Hamy.** (Comptes Rendus, 168. pp. 429–435, March 3, and pp. 484–489, March 10, 1919.)—In addition to collimation, level, and azimuth errors, it is necessary to consider pivot errors and lateral flexure. In order to determine these

without any additional apparatus being fixed to the instrument, which might alter its flexure, recourse is had to a double-reflection prism, relying on the property that the angle between the incident and emergent rays is unaffected by rotating the prism round an axis parallel to its edge. A collimator with a small hole in a diaphragm at its focus through which a light shines, is fixed with its axis in line with the rotation axis of the transit instrument, and the resulting beam of light is by means of two double-reflecting prisms sent through the object-glass to the eyepiece where its image can be bisected by a micrometric wire. This can be done in all positions of the instrument, and the residual deviations of the optical axis from whatever cause arising are faithfully indicated by the position of the bisecting wire, its motion being read off on the micrometer head. Full details are given of the resulting corrections.

In the second article, besides the formulæ for determination of the constants, there indicated, are given two additional notes, explaining how to correct for any want of invariability in either the relation of the collimator to the telescope, or the angular deviation of the double-reflection prisms.

W. W. B.

544. *Eclipse of* 1919 *May* 29 *and Influence of Gravitation on Light.* **A. S. Eddington.** (Observatory, No. 537. pp. 119–122, March, 1919.)—This gives a full account of the British official programme for the forthcoming eclipse, with a discussion of the reasons which have governed the decision to concentrate on the problem of the "weight" of light, and to determine whether rays passing close to the sun are deflected (1) 1·75″ in accordance with Einstein's theory; (2) half that amount in consequence of the gravitational effect of the sun's mass, or (3) not at all. The circumstances are specially favourable for the test, as the eclipse is of unusual duration and the sun will be in the direction of the Hyades, so that 13 stars may show on the plates taken of the region immediately surrounding the sun. Astrographic telescopes will be used, the Greenwich object-glass going to Brazil and the Oxford one to Principe Island off the West Coast of Africa. The author discusses other possible causes which may produce similar effects, indicating that "successful" results may not entirely settle the question. W. W. B.

545. *Central Temperature of Sun.* **A. Véronnet.** (Comptes Rendus, 168. pp. 398–401, Feb. 24, 1919.)—To satisfy the conditions of physical equilibrium there cannot be very great increase of temperature within the nucleus bounded by the surface of discontinuity (from 30 to 50 km. below the visible surface of the sun). The max. temperature at the centre should not exceed twice that of the surface. For reasons given, even this value of 12,600° appears too high, the conclusion being that it is very little above 10,000°, instead of the millions of degrees required by the formula for a perfect gas. The dilatation of eight times the volume at zero which the author assumes, justifies his previous conclusion as to the mean atomic weight being practically that of silver. [See Abs. 488 (1918) and 166 (1919).]

W. W. B.

546. *Secular Acceleration of Moon's Mean Longitude.* **E. Nevill.** (Roy. Soc., Proc. 95. pp. 300–302, Feb. 1, 1919.)—From a complete reduction of lunar observations since 1620, the conclusion is drawn that the theoretical value of the secular acceleration will fit the early solar eclipse observations, and the later Greenwich observations quite as well as the empirical value

adopted by Hansen in his tables. The mean of the observed errors of the tables for each year is written in a form which enables the less known terms to be eliminated, leaving only the long-period planetary perturbations. These are tabulated for every fifth year from 1640 to 1915, both for Hansen's adopted values and for corrected ones obtained by using the theoretical value of the motion instead of his empirical one. The main contention is thus plainly shown, and further deductions are drawn from the absence of the supposed anomalous secular acceleration, chief of which is that there is no evidence of tidal retardation of the earth's rotation. Reasons are given against the probability of such tidal effect on orographical grounds, unless in the solid body of the earth, in which case they must be very small and probably insensible. Therefore the outstanding periodic errors are satisfactorily explained as being due to Hansen's erroneous values of the long-period terms. W. W. B.

547. *Photoelectric Determinations of Stellar Magnitude of Planets.* **P. Guthnik.** (Astron. Nachr. No. 4976. Nature, 103. p. 53, March 20, 1919. Abstract.)—The method is applied to Saturn and Mars, the probable error of a determination being one-hundredth of a magnitude. Saturn is compared with Pollux at four oppositions, to allow for the effect of the changing aspect of the ring, without which it appears that the planet's brightness is practically constant, and ⅓ mag. brighter than Pollux. It is further inferred from the cycle distribution of the dates that sunlight does not vary sensibly during the sunspot period. Mars is compared with many standard stars, and the stellar magnitude varies through 2⅙ mag., according to the longitude of the face of Mars presented to the earth, and varies also at different oppositions according to the tilt of the axis and the "snow" or cloud conditions. W. W. B.

548. *Orbit of Comet* 1914*e* (*Neujmin*). **J. Svärdson.** (Stockholm, Observat. Astron. Iakt. 10. No. 6. [18 pp.], 1917.)—The author is satisfied that the orbit is hyperbolic ($e = 1{\cdot}00367 \pm 0{\cdot}000296$), with a large perihelion distance 3·747, though the 51 observations on 36 nights, mostly obtained at Mt. Hamilton and Vienna, only cover an arc of 84° of the orbit. The corresponding elements of a similar comet, of 1729, are given for comparison. W. W. B.

549. *Globular Clusters, Cepheid Variation, and Radiation.* **H. Shapley.** (Nature, 103. pp. 25–27, March 13, 1919.)—As commonly interpreted, the Helmholtz-Kelvin contraction and other less important known stores of energy, cannot have maintained solar radiation for twenty million years. But the sun has radiated at its present rate for more than a thousand million years. To strong geological evidence of a long time-scale astrophysical arguments are now added from investigations of star-clusters and variables. We require either the discovery of hitherto unrecognised sources of energy in the sun and stars (for which search is not encouraging, as gravitational, chemical, radio-active and other electrical sources are far too scanty), or else a modification of the physical theory. The suggestion is made that if energy is only radiated in directions where there are bodies to receive it, this difficulty and others may be solved [see Abs. 288 (1915)]. **F. Soddy.** (*Ibid.* p. 43, March 20, 1919.)—F. Soddy supports the suggestion that we only know of radiation between bodies, and cannot vouch for any such phenomenon as radiation "into space," suggesting an enormous waste. W. W. B.

550. *Star Clusters.* **C. V. L. Charlier.** (Lund Observat. Meddel. Ser. 2. No. 19. Nature, 103. p. 73, March 27, 1919. Abstract.)—Assuming that non-globular clusters do not differ much in size, their grouping seems very similar to that of B-stars, which implies that they are within the galaxy, and are probably in a system concentric with the B-stars. The region appears to be bean-shaped, the diameters in the galactic plane and at right angles to it being respectively of the order of 10,000 and 3000 light-years. For single clusters the distances are not reliable but that of *h* and χ Persei comes out at 400 light-years, in accordance with that deduced for Nova Persei.

The globular clusters similarly treated yield a configuration in agreement with Shapley's but on a much smaller scale, as these also appear to lie within the galaxy. The author maintains that the cluster variables are "dwarfs," though the Cepheids with similar light-curves are "giants." The brightest cluster-stars he finds to be of the 8th magnitude (absolute) ; nothing like so bright as Shapley's values. There are also other controversial points which need definite elucidation before Shapley's conclusions can be accepted.

W. W. B.

551. *New Variable Star.* **E. E. Barnard.** (Astron. J. 32. p. 37, March 28, 1919.)—An unusual type of star, which may be either a variable of very long period with a great range of magnitude, or an abnormal nova. No Harvard plates from 1891 to 1908 show the star at all, nor do Wolf-Palisa charts in 1904 and 1905 with about 3 hours' exposure, nor any of the author's plates previous to 1909. But in 1909 it is shown of 18·9 magnitude and the author has it on a photograph in 1915 of 10·5 magnitude. Several Harvard plates since 1909 show the star. W. W. B.

552. *Motion of* Σ208 *and* Σ1884. **E. Doolittle.** (Astron. J. 32. pp. 9–13, Feb. 13, 1919.)—These are two difficult double stars, of which the observations up to date of Burnham's Catalogue were said by Burnham to be consistent with the idea of rectilinear motion while Lewis in his memoir on the Struve double stars claims binary motion for both. The present paper, considering all the observations up to 1912, comes to the conclusion that Lewis is right, but the great uncertainty of the observations of Σ1884 since 1901 make it very doubtful whether the relative positions predicted for the next few years will be even approximately correct. More observations are therefore required as soon as possible. W. W. B.

553. *Proper Motions of Stars in Zone* 24°–32° *N. Declination in Relation to Spectral Type.* **F. W. Dyson** and **W. G. Thackeray.** (Roy. Astron. Soc., M.N. 79. pp. 201–209, Jan., 1919.)—The stars used are those to the 9th magnitude in the Astronomische Gesellschaft catalogues for these zones, and are included in the forthcoming Greenwich Catalogue for 1910, delayed by the war. The B8, B9 and A0 stars diminish in number away from the galaxy, while the F8 to G5 stars show an opposite tendency, the K0 stars being uniformly distributed. The proportion of stars with large proper motion increases to a sharp maximum for types G0 and G5. Of types B, A and M only a few stars have large P.M. and these are all bright stars. The solar motion is deduced from the various classes of stars and from the whole, omitting those of very large P.M. The apex deduced from the B- and A-stars has declination 35° ; from F5 to K0, about 50° ; and from K2 to M it reaches 65°. This progressive apparent change may be explained by the presence of an increasing number of stars belonging to the second stream among the K and M types.

The results are not altogether in agreement with those of Boss obtained from the brighter stars over the whole sky. W. W. B.

554. *Magnitude Observations of Five Wolf-Rayet Stars.* **C. Martin** and **H. C. Plummer**. (Roy. Astron. Soc., M.N. 79. pp. 196–200, Jan., 1919.)—Photographs taken in 1916, 1917, and 1918 of five Wolf-Rayet stars in Cygnus, numbering from 16 to 28 for the different stars, yield detailed comparisons, the comparison stars being as usual standardised by means of the χ Persei cluster. B.D. + 35°·4001, is a variable of slow type, B.D. + 35°·4013 of quick type, and B.D + 38°·4010 is also clearly variable ; no definite result is obtained for the other two stars B.D. + 36°·3956 and 3987. It seems that the majority of Wolf-Rayet stars are probably variable, but within narrow limits of perhaps a quarter of a magnitude in general. W. W. B.

555. *Nova Aquilæ*, 1918. **J. G. Hagen**. (Roy. Astron. Soc., M.N. 79. pp. 168–171, Jan., 1919.)—Photometric observations obtained at the Vatican Observatory, extend from June 13 to Nov. 5. The Revised Harvard photometry is taken as the standard, but grade and colour corrections are indicated, the former varying with the power used and the latter being affected by the "Purkinje phenomenon."

In the resulting light-curve minima are shown on June 27 and Aug. 5, and maxima on July 3, Aug. 7, and Aug. 30, another minimum probably occurring between Aug. 15 and 24 during which period no observations were obtained, and possibly other fluctuations between July 17 and 25 and between Sept. 12 and 29. The observations after Oct. 7 are regarded as of less value. The colour, when noted, was between orange and red.

W. W. B.

556. *Astrographic Catalogue.* II. (Nature, 103. p. 34, March 13, 1919. Abstract.)—Deals with the publication of the second volume of the Hyderabad zones, which contains measures of the plates with centres at 18° South declination. It includes 61,378 stars, mostly limited to those not fainter than the 13th magnitude, on which basis a total of 8½ million stars for the whole sky may be inferred. For each star position coordinates are given, and the measured diameters of the images, with a reduction formula for each plate to reduce the measures to standard magnitudes. W. W. B.

557. *Cause of Cepheid Variation.* **H. Shapley**. (Observatory, No. 538. pp. 168–170, April, 1919.)—This paper discusses the results given in the preceding one with a view to accounting for the behaviour of the lines by darkening at the limb. The apparent disc being divided concentrically into four equal areas, these are compared with the limiting radial velocities on the pulsation hypothesis, varying from 1 at the centre to 0 at the limb. The percentage of light on the hypothesis of uniform disc is 25 in each section, but with darkened limb the percentages are 35, 30, 23, and 12 respectively. Reasons are given for supposing the darkening at the limb to be greater still. Moreover, a difference of more than a magnitude in the brightness of two components of a spectroscopic binary makes it almost impossible to see the lines of the secondary. It is inferred that the outermost area would contribute nothing to the spectrogram, as it would probably be more than two magnitudes fainter. The third area would contribute very little for the same reason, and the second area would have very little difference to contribute, so that the observed shift of the lines and their narrowness do not oppose

the pulsation theory. There should, however, be a want of symmetry which is not at present shown, perhaps because of the difficulty of photographing secondary spectra. [See next Abs.] W. W. B.

558. *Cause of Cepheid Variation.* **W. S. Adams.** (Observatory, No. 538. pp. 167–168, April, 1919.)—Photographs of the spectrum of δ Cephei at maximum and minimum obtained at Mount Wilson on a scale of 5·3 Å. units per mm. at H_γ give lines nearly double the width at minimum as compared with maximum, partly due to under-exposure of the minimum photograph. The variation in radial velocity is 38 km. A spectroscopic difficulty in the pulsation hypothesis is that the stellar atmospheres contemplated by it would be so enormously disturbed that the narrow, well-defined lines characteristic of the Cepheids seem almost inconceivable. W. W. B.

559. *Distribution of Absolute Stellar Magnitudes in and near the Milky Way.* **W. J. A. Schouten.** (K. Akad. Amsterdam, Proc. 21. 4. pp. 518–532, 1919.)—Using in addition to published star-counts some mean parallaxes in advance of publication by Kapteyn and van Rhijn, the author endeavours to find the luminosity law for the whole sky and for five zones of galactic latitude (<10°, 10° to 30°, 30° to 50°, 50° to 70°, and >70°). He gives a list of catalogues used, and the limits of magnitude and proper motion used in the classification. 33,818 proper motions were used for the whole sky, and 8273, 10,857, 6981, 3144, and 1488 stars were counted in the five zones in order. The total indicated in the author's table for the whole sky exceeds a million and a half, brighter than the 12th magnitude. Employing Kapteyn's method with his three hypotheses, one of which is that there is no absorption of light in space, a much larger total is found. Other methods are discussed and frequency curves given both for the author's own discussion and for Schwartzschild's method applied to the same data, an attempt being made to reconcile all the differences found. One of the main conclusions indicated is that the frequency curve does not vary with the distance, and if this is true Kapteyn's contention that there is no perceptible absorption of light in space is justified. W. W. B.

560. *A Critical Magnitude in the Sequence of Stellar Luminosities.* **H. Shapley.** (Mt. Wilson Solar Observat. Contrib. No. 155. Astrophys. J. 49. pp. 96–107, March, 1919.)—This is the tenth paper of the author's series of studies of stellar clusters. He finds that no star of absolute magnitude fainter than —0·2 mag. is liable to Cepheid variation, and thinks this brightness probably corresponds to a turning-point in the development of internal structure. The discussion deals principally with Messier No. 3, but M.2, M.5, M.13, and M.15 are also studied, some 5000 stars in all, to test the presence of analogous dynamical changes for all giant stars, whether variable or not, and curves are given showing the results. He confirms the result that for M.3 the very bright stars are red and the fainter ones blue. M.13 is very rich in blue stars at medium magnitude, though it has few cluster-type variables. W. W. B.

561. *Absorption Lines in Spectra of Novæ.* **F. E. Baxandall.** (Observatory, No. 538. pp. 163–165, April, 1919.)—The author denies the implication [see Abs. 264 (1919)] that he recognised no genuine absorption lines in the spectrum of novæ. While admitting some of Lunt's identifications as

superior to his own, the author objects to others, and in particular claims that the Nova lines near 4924 and 5018 do not belong to He, but to Fe.

W. W. B.

562. *Vertex of Stellar Motions.* **L. Boss** [*the late*] and **H. Raymond.** (Astron. J. 32. pp. 17–20, Feb. 18, 1919.)—From the proper motions in Boss's Preliminary General Catalogue, omitting those within 45° of Eddington's vertex or anti-vertex, the distribution of motions appears to indicate a loose, fairly definite cluster and some outlying groups of points. All seem more or less elongated. A least-square solution gives vertex in R.A. 6h. 15·2m. and Decl. + 7·0° with a preponderance of negative residuals, especially in the Northern Hemisphere. The original estimate of 7 : 4 for the ratio of two of the principal axes is revised, the final result being three unequal axes in the ratio 2·2 : 1·3 : 1.

W. W. B.

563. *Short-period Variable RR Ceti.* **C. Martin** and **H. C. Plummer.** (Roy. Astron. Soc., M.N. 79. pp. 190–195, Jan., 1919.)—From 41 photographs a period of 0·553024 day is deduced, in good agreement with 0·553022 day determined by L. Pračka in 1908 from his visual observations, but the photographic light-curve shows less flatness at maximum and minimum. The effect of the 3rd, 4th, and 5th harmonics taken alone gives a disturbance curve very similar to that found for RZ Cephei: in fact, of seven stars with period of about half a day, these two with RS Boötis, XZ Cygni, and SW Draconis, or five in all, show this type of secondary variation; in a sixth, RR Lyræ, it only breaks down at the fifth harmonic; and in one only, SU Draconis, is the disturbance of a different type.

W. W. B.

564. *Pulsation Theory of Cepheid Variables.* **J. Evershed.** (Observatory, No. 537. p. 124, March, 1919.)—The writer points out that owing to the general absorption of the sun's atmosphere, only the central portion of the disc shows up in daylight spectrum photographs and not the part where the line-of-sight rotation velocity is greatest. Hence the lines are very slightly widened. In the Cepheids, though the radial velocity is eight times greater, the dispersion employed is not more than 5 % of that used for the sun, so that if these stars which are of solar type have atmospheres as absorptive as that of the sun, their lines cannot be expected to be diffuse.

W. W. B.

LIGHT.

565. *Vacuum-Grating Spectrograph for Use in Extreme Ultra-Violet.* **J. C. McLennan** and **R. J. Lang.** (Roy. Soc., Proc. 95. pp. 258–273, Feb. 1, 1919.)—Describes in detail, with numerous diagrams, the construction of a vacuum-grating spectrograph with which observations have been made of wave-lengths as short as λ584 Å.U. A preliminary account is also given of observations made with the instrument, using arcs of Hg, Cu, Fe, and C. Mercury lines were observed down to λ1435, iron lines to λ1427, and with carbon the shortest wave-length observed was λ584. The limit reached with copper was λ1925. A. W.

566. *Tyndallmeter for Examination of Disperse Systems.* **R. C. Tolman** and **E. B. Vliet.** (Am. Chem. Soc., J. 41. pp. 297–300, March, 1919.)—Describes with elaborate drawings a convenient form of Tyndallmeter for determining the strength of the Tyndall beam in suspensions, colloidal solutions, smokes and mists. E. H. B.

567. *Relation between Intensity of Tyndall Beam and Concentration of Suspensions and Smokes.* **R. C. Tolman, L. H. Reyerson, E. B. Vliet, R. H. Gerke,** and **A. P. Brooks.** (Am. Chem. Soc., J. 41. pp. 300–303, March, 1919.)—The relations are shown by graphs, with meter readings as ordinates and concentration as abscissæ. For silica suspensions the relation is at first linear, reaches a maximum, and then slightly falls for higher concentrations. For NH_4Cl smoke, the relation is linear. E. H. B.

568. *Scattering of Light by Air Molecules.* **J. Cabannes.** (Comptes Rendus, 168. pp. 340–343, Feb. 17, 1919.)—The results obtained by the author [Abs. 481 (1915)] and by Strutt [Abs. 835 (1918)] have been called in question by Wood [Abs. 1151 (1918)]. The object of the present paper is to show what precautions are necessary to avoid phenomena which complicate the simple scattering effect. When these phenomena are eliminated, the results obtained afford a qualitative and quantitative verification of the theory given by Rayleigh. The proportionality existing, according to Rayleigh's theory, between the luminous intensity scattered laterally by a transparent gas and the number of molecules which occupy the volume illuminated has been verified with considerable precision by a method of photographic photometry, the pressure in the containing vessel being varied from 770 to about 400 mm. of mercury. If high-frequency radiation is employed complications are introduced, and so it is necessary to suppress radiation of wave-length less than 0·3 μ. A. W.

569. *Failure of Classical Optics.* **M. v. Laue.** (Deutsch. Phys. Gesell., Verh. 19. pp. 19–21, Feb. 28, 1917.)—If many diffracting particles are distributed irregularly over a plane surface F, then, according to Rayleigh, we see in the diffraction image certain fluctuations of intensity. The distance between two points P and P′ in the diffraction image, upon which statistically the intensities E and E′ depend, are (according to classical optics) of the order of magnitude of the diffraction image corresponding to the surface F. This is contradictory to experience. The point is then discussed on Planck's quantum theory. E. H. B.

570. *Colour and Dispersion of Particles in Coloured Solutions.* **W. Harrison.** (J. Soc. Dyers, 33. pp. 7–8; Disc., 8–9, Jan., 1917.)—The colour of colloidal particles is not a question of grain size; colloidal gold may be obtained in colours ranging from red to blue, as Siedentopf and Zsigmondy showed, according to whom the colour partly depends upon the distance between the particles. Mathematically this was shown by J. C. M. Garnett [Abs. 2523 (1904)]. The author repeats the experiments of Ostwald on colloidal solutions of night-blue, Victoria-blue, and other colouring matters. The night-blue first dissolves in acid with little change in colour, but is then precipitated and in redissolving turns green and yellow. In glacial acetic acid the colour change is violet, blue, green, yellow without visible change in the size of the particles, to which Ostwald had attributed the change in colour. The author sees the cause in molecular rearrangements, possibly accompanied by changes in the sizes of the aggregates. Reference is made to Chapman Jones on the colours of photographs. **J. R. Hannay** criticised the selection of the compounds experimented with. H. B.

571. *Achromatic Fringes in Self-adjusting Interferometer.* **C. Barus.** (Nat. Acad. Sci., Proc. 5. pp. 53–58, March, 1919.)—A note on the use of the achromatic fringes in the Michelson-Morley interferometer, and their application to the determination of the indices of refraction either of a glass plate or of an object of less simple form. J. W. T. W.

572. *Dispersion of Light in Substances with Anisotropic Molecules.* **M. Born.** (Deutsch. Phys. Gesell., Verh. 19. pp. 243–264, Nov. 30, 1917.)—A mathematical treatment of the subject. [See Abs. 1537 (1908).] A. W.

573. *Dispersion of Light in Hydrogen, Oxygen, and Nitrogen.* **M. Born.** (Deutsch. Phys. Gesell., Verh. 20. pp. 16–32, Feb. 28, 1918.)—An application of the theory previously given [see preceding Abs.] to the gases H, O, and N. A. W.

574. *Colours of Colloids.* II. **W. D. Bancroft.** (J. Phys. Chem. 23. pp. 1–35, Jan., and pp. 154–185, March, 1919.)—A continuation of previous work [Abs. 292 (1919)]. The present paper deals with reflection and refraction. A. W.

575. *Uncemented Two-Lens Objective.* **K. Yamada.** (Phys. Math. Soc. Japan, Proc. 1. pp. 35–38, Feb., 1919.)—Gives a method for the correction of a two-lens objective calculated on the assumption of thin lenses. The method enables the spherical aberration to be reduced (without affecting the coma or chromatic aberration) by alteration of the air interval. J. W. T. W.

576. *Residual Aberration of Central Optical Systems.* **K. Yamada.** (Phys. Math. Soc. Japan, Proc. 1. pp. 29–35, Feb., 1919.)—Gives a method for obtaining the residual aberrations of a given lens system by the application of v. Seidel's formulæ. The method is exemplified by application to a particular case of a heliometer objective. J. W. T. W.

577. *Specular Reflection from Rough Surfaces.* **T. K. Chinmayanandam.** (Phys. Rev. 12. pp. 96–101, Feb., 1919.)—It is well known that matt surfaces behave nearly in the same way as polished reflectors when the incident rays are of great wave-length or fall very obliquely on the surface. Gorton [Abs. 819 (1916)] has followed up the work of Rayleigh and Meyer [Abs. 841 (1914)] on this subject, and has given several curves showing the relative reflecting power of surfaces of ground-glass as compared with that of a polished surface of the same material, for various angles of incidence and for various wave-lengths of incident radiation. The present paper records the results of an attempt made to develop a mathematical formula which would quantitatively express the relative reflecting power of a rough surface over the range of incidences and wave-lengths studied by Gorton. Comparison tables are given between the calculated values and Gorton's observed values, fairly good agreement being obtained. A. W.

578. *Theory of Imperfect Gratings.* **C. M. Sparrow.** (Astrophys. J. 49. pp. 65–95. March, 1919.)—An attempt is made to present the whole subject afresh from the standpoint of the so-called vector method. The first part of the paper considers systematically the various kinds of defects which are likely to occur in practice. Many well-known results appear in the new treatment; many others, not so well known, are nevertheless contained by implication in the already published work of others, but have hitherto failed to receive the emphasis which their importance demanded. In order to increase this emphasis, curves showing the forms of diffraction patterns are included, and numerical data, which have been obtained by ordinary processes of calculation, are given.

The second part of the paper applies some of the results obtained in the first part to an examination of the limitations of the method of coincidences as a means of measuring wave-length. It contains, in addition, a theory of the defective Fabry and Perot interferometer, with consequences relating to this method of measuring wave-lengths. A. W.

579. *Adaptation of the Eye for Low Illuminations.* **P. Metzner.** (Deutsch. Phys. Gesell., Verh. 20. pp. 183–186, Oct. 30, 1918.)—Describes apparatus used for experiments on the time required for the adaptation of the eye to illumination of very low intensities. The "adaptometer" employed for this purpose consisted of a surface of radium luminous compound, and experiments described in the paper show that the duration of the phosphorescence excited by exposure to light depends on the intensity of the illumination to which the material has been exposed, and also on the length of the exposure. After an hour's exposure to full sunlight, a period of 6 hours is required for return to normal luminosity in the particular sample of compound used. J. W. T. W.

580. *Photometers for measuring the Candle-power of Flares, Parachute Lights, etc.* **A. P. Trotter.** (Illum. Eng., London, 11. pp. 253–259, Nov., Disc., 269–276, Dec., 1918.)—The paper summarises photometric researches on flares and other high c.p. fluctuating sources, undertaken for the Ministry of Munitions by a committee of the Illuminating Engineering Society. The rate of burning is irregular and the c.p. varies within wide limits. Accordingly photometers involving manipulation of parts to obtain a reading were not suitable. The illumination must be determined by visual inspection. Two forms of apparatus are described. In one case a tube 25 in. long and 3 in. in diam., with a white interior, is illuminated with a small lamp at one end. A slot 2 in. wide is cut out nearly the length of the photometer and covered by a whitened strip of thin metal having perforations in the form of letters. This strip receives the illumination to be measured and its brightness can be balanced by comparison with the progressively increasing brightness of the interior of the tube, as seen through the series of letter-perforations. The illumination corresponding with each letter is determined in the laboratory. The instrument is set up vertically at a convenient distance from the flare, which is suspended on a pole, and observations taken at a distance of 8–10 feet, usually at intervals of a few seconds. The average c.p. throughout the period of burning is taken, and the results expressed in c.p.-seconds per gm. of composition. The other apparatus is similar in principle, but the observer looks at an illuminated test-surface through a series of slots in a screen of graded brightness, illuminated by a lamp adjacent to one end. The range of reading can be extended by choosing surfaces for screen and exterior test-card of convenient reflecting power. Charts are presented showing variation in brightness with time of typical flares, the c.p. of which in some cases attained 120,000–180,000. Observations were also made of the illumination derived from flares attached to military kites. J. S. D.

581. *A New Process of Printing on Paper in Natural Colours.* **S. H. Williams.** (Phot. J. 59. pp. 88–95, March, 1919.)—The main objection to the ordinary way of attempting three-colour work is the necessity for three separate exposures, since, except under the very best lighting conditions, it practically limits the worker to still life; for portraits are almost out of the question when three plates have to be exposed in succession, and the same is true of landscapes which include clouds. None of the devices invented to overcome this trouble are free from objection. A much simpler method of working, and one that would get the three-colour impression at a single exposure on a single plate, would be to use a three-colour filter. Two conditions in the use of such a screen are extremely important: first, that the three-colour screen must be of such a character as to enable a separate print to be made readily from the parts filtered by each of the three colours; and, secondly, that the colour elements shall be so finely divided as to give the effect of a continuous picture. The three colours of which the screen eventually evolved is composed are red, green, and blue, and they are arranged right across the plate in straight lines, the colours alternating. If a suitable plate be exposed behind such a screen one-third of the plate—that is to say, the finely-divided parts which come behind the red lines—will be filtered by the red, another third by the green, and the final third by the blue. If a print can be made from the parts which come behind each set of lines, and the lines are sufficiently fine to give the effect of a continuous picture, then the equivalent of the three-colour impressions, either in black and white or in colours complementary to the colours on the screen, that a worker of the ordinary method gets from his three separate negatives will be obtained. In order to carry this out it is necessary to have another screen which consists simply of black lines and clear spaces. The black lines are the same number to the inch as the lines of each colour in the colour screen, namely, 180 to the inch, or in the case of the colour screen, 540 lines of the three colours. But the black lines in this other screen are just twice the width of the spaces in between, or equal to the width of two contiguous lines of different colours in the colour screen. Now in the case of the negative which has been exposed behind the colour screen, the key plate makes it possible to cover up, not two colours, but those parts of the plate which have been filtered by those two colours and to make a print from the exposed portion. Full details of the method of using the screen and key-plate are given, as is also a description of the process by which the screen is prepared. The "bromoil" method is the one described by the author in connection with this new process. A. E. G.

582. *On the Theory of Opalescence.* **R. Lundblad.** (Ann. d. Physik, 57, 8. pp. 581–627, Jan. 10, 1919.)—The problem of light extinction in gases has been frequently treated from different standpoints without, however, producing a generally accepted theory. The experimental data are necessarily scanty on account of the insignificance of the effect to be observed in ordinary gas layers. In consequence, experimental work has been mainly confined to long columns of air The composition of the atmospheric layers is, however, beyond control, and the efforts of investigators have been expended in making a fairly rough confirmation of Rayleigh's extinction laws, and the polarisation conditions for scattered light. The theoretical significance of the Rayleigh formulæ $h = 32\pi^3(n-1)^2/3N\lambda^4$ has hitherto remained unsolved. This expression follows from the assumption that extinction is due to the presence of small dielectric spheres in the medium, N being the number of spheres per unit volume, and n the refractive index of the medium so modified. Rayleigh himself asked whether the gas molecules themselves would involve such a non-homogeneity as to promote extinction, and concluded that the light scattered from the molecules would suffice to give a blue sky not so very greatly darker than that actually enjoyed. The extinction by dust could therefore be replaced by an extinction due to single molecules. Planck has more recently attempted to elucidate the inner mechanism of this phenomenon, and for this purpose has applied to it his theory on the radiation damping of resonators. The equation of the oscillating dipole is $Kf + Lf'' - 2f'''/3c^3 = Z_0'$, where f is the electric moment of the dipole, Z_0' the exciting field strength, c the velocity of light *in vacuo*, and K and L are constants. The third term of this equation gives the damping by radiation, and accordingly has been regarded as the characteristic of the Planck theory. Objections against the theory have been raised by Mandelstam and Oseen, while support has been given by Gans and Happel, and Lorentz. The latter views are discussed and the standpoint obtained that the statistical properties must exert an observable influence upon the opalesence radiation—a view already stated in 1908 by Smoluchowski, who sought from statistical fluctuations of density, especially in the neighbourhood of the critical point, to arrive at a granular structure which would be a cause of opalescence. The Rayleigh formula was also obtained by Einstein from the standpoint of Maxwell's medium dynamics, and by Lorentz in more simplified manner from the same basis. The problem arises as to whether these two sources of opalescence, *i.e.* the molecular damping and the density fluctuation hypotheses, are really identical or are different. The present paper is an attempt to solve this problem, and the author deems it inevitable to investigate each cause of extinction from the molecular standpoint. The recent work of Sommerfeld, Esmarch, and Nathanson on the propagation of electromagnetic waves has afforded results which are here applied by the author. Section 1 of the paper discusses the density problem. Section 2 deals with the properties of molecular resonators. In section 3, the exciting force is considered. Section 4 deals with the calculation of the exciting force, and of the resonator moment. Section 5 investigates the field and also deals with homogeneous bodies. Section 6 considers the opalescence field to a first approximation, and section 7 to a second approximation. The general results obtained are shortly summarised as follows:—The field around the body considered is composed of the diffraction phenomena and the special field due to opalescence. The latter only appears when density fluctuations are present, in which case also the radiation term in the oscillation equation occurs. If there be no density fluctuations, then the opalescence field vanishes and with it the radiation term in the equation. The author has replaced the Rayleigh formula for diffuse scattering of light by another which also contains the absorption index for incident light, and which remains valid for absorption of any strength. The Rayleigh formula appears as a special case of the above general expression. The general formula holds good for the influence of density fluctuations upon molecular oscillations within a very wide pressure interval. H. H. Ho.

583. *On the Perpendicular Passage of Linearly Polarised Plane Waves through Plane Parallel Plates of Transparent Inactive Crystals.* **M. Berek.** (Ann. d. Physik, 58. 2. pp. 165–198, Feb. 14, 1919.)—In the usual theory of the interference phenomena accompanying the perpendicular incidence of polarised light on transparent inactive crystals, analogy is made to the parallelogram of forces by a geometrical decomposition of the amplitude into components at right angles at the boundary surfaces of the anisotropic media. This process entails two drawbacks, in that: (1) it takes no account of wave absorption in the crystal; and (2) it leaves unconsidered the weakening of the amplitudes by reflection at the boundary surface. So long as the special vibrations of the crystal are widely removed from the visible spectrum region, as is the case for completely transparent media, then the absorption is small in the visible spectrum and not appreciably different for both waves in the anisotropic medium; in consequence this drawback may be neglected. The same would apply for reflection if both waves were weakened to a like degree, but such, however, is not the case. The reflecting power is dependent on the value of the refractive index. In consequence the amplitudes of both emergent waves are weakened to a different extent by the double reflection at the boundary surfaces which depends on the magnitude of the double refraction. Satisfactory agreement is shown in the case of weak double refraction, between the geometrical theory of interference phenomena and the practical results. Experimental work, however, is lacking for the case of crystals having powerful double refraction, and since during the last decade optical methods have become very exact, the author considers the problem now merits further attention. Section 2 of the paper deals with the reflection and refraction of plane waves having perpendicular incidence on plane parallel plates of inactive transparent crystals. Section 3 considers the normal position of the crystal plate, and section 4 the geometrical and electromagnetic diagonal positions. In section 5 the influence of the refractivity of the enveloping isotropic medium is investigated. Section 6 deals with the secondary dispersion of the polarisation planes during the perpendicular passage of light through plane parallel plates of uniaxial inactive transparent crystals. Section 7 considers the dispersion of δ (the difference of angle between the electromagnetic and geometric diagonals) for biaxial crystals. The next three sections are devoted to orthoscopic methods of measurement. The term orthoscopic is not used here as in geometrical optics, but according to Rinne's definition with respect to the interference phenomena in perpendicularly incident polarised light; the term konoscopic is employed for interference phenomena in convergent polarised light. Section 8 describes the determination of the extinction directions. Section 9 deals with the measurement of differences of path, and section 10, with the analysis of elliptically polarised light. Section 11 is devoted to a summary of the essential results. By oblique incidence the two waves emerging from a doubly-refracting crystal plate are not, in general, polarised exactly parallel to the waves propagated in the

crystal plate; also their planes of polarisation are not exactly at right angles to each other. With perpendicular incidence, however, the polarisation planes of both emergent waves are parallel to those in the crystal plate; but differences arise for the polarisation relations of the resulting waves between the results obtained on the electromagnetic theory and those on the geometric hypothesis. These deviations are well explained by means of the equation $\tan \delta = \frac{n_1(n_2+n_0)^2 - n_2(n_1+n_0)^2}{n_1(n_2+n_0)^2 + n_2(n_1+n_0)^2}$, where n_0, n_1, n_2 are the different refractive indices, and δ is the angular difference above explained. As a rule δ increases with the double refraction. In consequence of the dispersion of δ, there is entailed a secondary dispersion of the polarisation directions of the emergent waves, even with uniaxial crystals. By immersion of the crystal plate in a medium of higher refractive index than air, the differences between electromagnetic and geometric theory may be diminished or entirely removed. These phenomena occur in the so-called completely transparent media, and are solely a consequence of double refraction. In crystals having strong double refraction the differences are of such magnitude that they should be capable of determination without difficulty. H. H. Ho.

584. *Absorption Spectra and Ionisation Potentials of Ca, Sr, and Ba.* **J. C. McLennan and J. F. T. Young.** (Roy. Soc., Proc. 95. pp. 273–279, Feb. 1, 1919.)—The spectrum of Ba has been investigated, and the first ten members of the series $\nu = (1{\cdot}5, S) - (m, P)$, whose first member was given by Lorenser as 5539·69 Å.U., have been measured. Successful work on the absorption spectra of Ca and Sr opened up the way for the good results obtained with Ba. Assuming that the ionisation potentials for the atoms of Hg, Zn, Cd, etc., are given by the quantum relation $Ve = h\nu$ where ν is given by the frequency relation $\nu = (1{\cdot}5, S)$, the following results are obtained :—

Element.	λ (ν = 1·5, S.)	Ionisation Potential Calculated from V = (1·5, S.)h/e.
Mercury	1187·98 Å.U.	10·45 volts
Zinc	1319·95	9·4
Cadmium	1378·69	9 0
Magnesium	1621·7	7.65
Calcium	2028·2	6·12
Strontium	2177·5	5·7
Barium	2380·56	5·21

The value of h used was $6{\cdot}585 \times 10^{-27}$ erg. sec., and that of $e = 4{\cdot}774 \times 10^{-10}$ e.s. unit. The experiments of Tate and Foote point the way for a direct determination of the ionisation potentials of the vapours of Mg, Ca, Sr, and Ba, and it will be interesting to see whether the experimental values so obtained agree with the values calculated from the limiting frequencies of the singlet series of their spectra. A. W.

585. *Emission and Absorption in the Infra-Red Spectra of Hg, Zn, and Cd.* **R. C. Dearle.** (Roy. Soc., Proc. 95. pp. 280–299, Feb. 1, 1919.)—In a previous paper [Abs. 1345 (1916)] the author showed that well-marked absorption bands exist in the infra-red region of the spectrum caused by passing white light through non-luminous Hg vapour. This investigation

has been extended further into the infra-red with Hg vapour, and experiments have also been made with the vapours of Zn and Cd. The results serve to establish at least a partial parallelism in the behaviour of the three metals, the resemblance being most marked in the region of the first line of the series represented by $\nu = (2\cdot5, S) - (m, P)$, at which wave-length absorption takes place in the case of all three metals with extremely small vapour pressures. On account of the ease with which the wave-length corresponding to $\nu = (2\cdot5, S) - (m, P)$ was absorbed it was suspected that it should be emitted under electronic bombardment. An investigation was undertaken with Hg vapour in order to determine the speed which electrons must be given in order to stimulate emission of the wave-length λ1·014. Using the quantum relation $Ve = h\nu$, the calculated value of V for this wave-length was found to be 1·26 volts. In the experiments it was found that the wave-length λ1·014 was actually emitted with a voltage as low as 5 volts. There were strong indications that even a lower voltage would suffice, but under the conditions of the experiment the radiations of this wave-length when emitted were reabsorbed by the intervening layers of mercury vapour. The results of the whole investigation are discussed at some length. A. W.

586. *New Lines in the Extreme Ultra-Violet of Certain Metals.* **D. S. Ainslie** and **D. S. Fuller.** (Roy. Soc. Canada, Trans. 12. pp. 65–78, June–Sept., 1918.)—The experiments here described form an extension of the recent work of Lyman, Handke, Wolff [Abs. 289 (1914)], and Saunders [Abs. 775 (1916)] on the extreme ultra-violet region. A fluorite vacuum spectroscope was employed in conjunction with a vacuum arc lamp. The vacuum arc spectra of Cu, Zn, Al, C, Fe, Sn, Pb, Tl, Ni, and Co were studied between λ2400 and λ1400. Tables are given of the wave-lengths of the lines measured. The spectra obtained for Cu, Zn, and Al were found to correspond with the results obtained for the spark spectra of these metals by previous observers. For Sn, Pb, and Tl Saunders has given measurements between about λ2400 and λ1800, which correspond fairly well with the results now given. Several new lines have been observed and measured between λ1800 and λ1400. For the arc spectra of Fe, Co, Ni, and C several lines were observed and measured, some of which corresponded with results given in previous work. A. W.

587. *Vacuum Arc Spectra in Extreme Ultra-Violet.* **J. C. McLennan, D. S. Ainslie,** and **D. S. Fuller.** (Roy. Soc., Proc. 95. pp. 316–332, March 15, 1919.)—The vacuum arc spectra of Cu, Zn, Al, C, Tl, Sn, Pb, Fe, Co, Ni, and Cd have been investigated down to λ1400. The measurements for the vacuum arc spectra of Cu, Zn, Cd, and Al are well covered by the results for the spark spectrum of these metals, as obtained by previous workers. For Sn, Pb, and Tl Saunders has given measurements down to λ1700, and the results of his work have been found to correspond fairly well with the results now given. Below the region covered by Saunders' work many new lines have been observed and measured. The measurements for the vacuum arc spectra of Fe, Co, Ni, and C appear to be the first obtained for the arc spectra of these substances in the Schumann region. For these spectra nearly all the measurements down to λ1850, as given in the present paper, are covered by previous work on the spark spectra of these substances, but in the region between λ1850 and λ1400 several new lines have been photographed and measured. Photographs are given of the vacuum spectrograph and typical spectrograms of the substances dealt with. A. W.

588. *The Positive Ion as Carrier of Light-Emission in the Fluorescence produced in Inorganic Salts by Canal Rays.* **S. E. Ohlon.** (Deutsch. Phys. Gesell., Verh. 20. pp. 9–15, Feb. 28, 1918.)—The object of these experiments is to demonstrate the part played by the positive ions in the production of an emission of light when subjected to the action of the canal-rays. A special discharge tube is devised for the purpose, and details of the experimental results obtained with it are given. A. E. G.

589. *Band Spectra and Molecular Quanta Rotations.* **M. v. Laue.** (Deutsch. Phys. Gesell., Verh. 19. pp. 130–138, July 30, 1917.)—Schwarzschild has recently, by means of the quanta theory, attempted to establish Deslandres' formula $\nu = a + bm^2$ for the vibration number ν of the spectral lines in several bands. For this purpose he has assumed an electronic system circulating about a rotating molecule, in which the molecular charges are distributed in a centric symmetrical manner, so that the rotation does not influence the electronic motion by changes of the electric field, and *vice versa*. Whether the magnetic field of the rotation exerts any influence or not, has been overlooked. The present author now tests this hypothesis by application to the Zeeman-effect, and investigates primarily the influence of an external magnetic field upon the quanta rotations. This appears to offer a suitable means of testing, since the anomalous or positive band effect has been found with band lines, and appears to be explained by the activity of positive electrical carriers. Unfortunately the result obtained is that the changes of the quanta rotations, which must be ascribed to the magnetic field when application of the Sommerfeld-Epstein rules is made, give a much too small change in the vibration number. Previous authors have found the quanta theory defective for the explanation of the Zeeman-effect on series lines, and the question arises as to whether the operation of the Sommerfeld-Epstein rules is admissible in cases of forces without potential energy such as the magnetic field exerts upon moving electric charges. The connection between the actual Zeeman-effect for series lines and that calculated on the quanta theory is so strict that confidence may be placed in these calculations. Section 1 of the paper, which is mathematical throughout, deals with the Hamiltonian function, section 2 with the Hamilton-Jacobian equation and its solution, section 3 with the quanta conditions, and section 4 with a discussion of the results. The author concludes that there is no possibility of bringing Schwarzschild's hypothesis on the origin of the band spectra into connection with the observations on the Zeeman-effect, although there is just the possibility that the electrons may have a rotation, in addition to their translatory motion, which by magnetic influence would give a Zeeman-effect of the required dimensions. H. H. Ho.

590. *Resonance Spectra.* **H. Nagaoka.** (Phys.-Math. Soc. Japan, Proc. 1. (Ser. 3.) pp. 60–66, March, 1919.)—In a paper on resonance radiation and the quantum theory, Chinmayanandam has given an interesting discussion of the subject in the light of Bohr's hypothesis as regards the origin of spectrum lines. He finds from Wood's observations on the resonance spectra of iodine vapour that the spacing does not follow the law of constant frequency-difference, but that the square roots of the wave numbers are arranged at nearly constant intervals. This at first sight seems singular, but closer examination shows that this is but one aspect of the band spectrum and belongs to the most simple case of Deslandres' formula. The law governing the separation of the lines of resonance spectra indicates that the electron motion chiefly concerned is that normal to the plane of the ring. In the usual band spectra the electrons giving rise to the vibrations may be confined to a single ring, but in the case of resonance spectra, all the rings are simultaneously affected, so that the mutual reactions between the systems of rings are somewhat altered from the usual manner of looking at the problem. In addition to this, the attracting nucleus is affected and deflected from the plane of the ring. This naturally modifies the state of motion from that obtained by the ordinary means of excitation of spectra. Consequently the resonance spectra must differ from the spectra of the self-luminous source, inasmuch as the vibrations are caused by the forced vibrations of the electrified particles of the atoms or molecules due to the electromagnetic force of the light-wave. The author has previously shown that the vibrations normal to the plane of the rings are such as to admit of the frequency interval being very small compared with the radial vibrations; the usual appearance of the resonance spectra can be easily accounted for on the ground that all the rings as well as the central nucleus are simultaneously affected. A discussion is given of this hypothesis, with special reference to the intensity of the lines, to their partial polarisation, and to the absence of any Zeeman-effect. The subject will be considered quantitatively in a subsequent paper. A. W.

591. *X-ray Spectra and the Constitution of the Atom.* **L. Vegard.** (Phil. Mag. 37. pp. 237–280, March, 1919.)—In this paper, which is the continuation of a former one [Abs. 530 (1918)], the author discusses in further detail the various possibilities of the process of recombination, firstly, whether the angular momentum of each electron left behind in the atom, or the energy of the unbroken system remains unchanged; secondly, whether the recombination is between primaries, from a disturbed primary, or from secondaries; and thirdly, whether in the case of recombination from secondaries, Debye's hypothesis affords a possible alternative to the conservation either of momentum or energy. The author's final conclusion is that if his proposed scheme of X-ray production be accepted, he can see no escape from the assumption that recombination takes place from secondary systems, and that the angular momentum of the electrons left behind in the atom remains constant during expulsion and recombination. The paper concludes with some general remarks on atomic constitution, in the course of which he points out that the constitution here given for the K-, L-, and M-ring involve certain modifications in the general scheme of his former paper, with regard to the constitution of the elements, and that further consideration of the variation of atomic volume on the basis of his scheme with regard to the constitution of the surface system leads to the conclusion that, while the atomic volume is doubtless greatly influenced by the magnitude of the radius of the surface ring, other influences, notably the particular forms in which the atoms are grouped in the condensed aggregate forms, may even more than counterbalance the effect due to change of radius. This variation of atomic volume favours the author's two fundamental assumptions: All elements belonging to the same period have the same quant-number. The quant-number increases by one unit when we pass from one period to the next one. Also, when we consider the atomic volumes, the best agreement is got when the quant-number of the first period is put equal to 1.

While the author's scheme accounts for many properties of the elements, there are noteworthy disagreements, *e.g.* Mn, according to it, should possess properties similar to those of the halogens, and the scheme in no way accounts for the singular position of the inert gases.

The author suggests that this incompleteness may be due to the mechanism of atomic constitution not being determined only by the number of electrons of the rings and their quant-numbers. For the electrons of any one ring are constrained into definite orbits, either circular or elliptic, and these may be like similar constraints arising from interaction of the ring systems, and these interactions may modify the chemical and physical properties of the atoms. Moreover, the scheme may be correct for the surface-systems, and these may not entirely determine the atomic properties. G. W. de T.

592. *On the Theory of X-ray Spectra.* **L. Vegard.** (Deutsch. Phys. Gesell., Verh. 19. pp. 328–343, Dec. 30, 1917.)—Deductions from the theories of Debye [Abs. No. 51 (1917)] and of Bohr relating to X-ray spectra and atomic structure. The paper deals mainly with the question of the number of electrons in the rings of the atoms, and the emission of radiation when an electron transfers from one ring system to another. Reference is made to the various experimental results recently obtained relating to the K, L and M series. A. B. W.

593. *Scattering Coefficients of X-rays.* **H. Holthusen.** (Phys. Zeits. 20. pp. 5–12, Jan. 1, 1919.)—A method is described which distinguishes between true absorption and true scattering when a narrow beam of X-rays falls upon a screen of scattering material. Suppose g/ρ, μ/ρ, and s/ρ are respectively the total absorption coefficient, the true absorption coefficient, and the scattering coefficient for a certain material (ρ being the density of that material). Then $g/\rho = \mu/\rho + s/\rho$ and for a second material $g'/\rho' = \mu'/\rho' + s'/\rho'$. In the particular method described $s/\rho = s'/\rho'$ and $\mu/\rho : \mu'/\rho' = A$, whence

$$s/\rho = s'/\rho' = (Ag'/\rho' - g/\rho)/(A - 1),$$

an equation giving directly the value of the scattering coefficients. A detailed study has been made of Al, water, potassium nitrate, carbon, and paraffin. A. B. W.

594. *Emission of Secondary X-rays.* **A. Müller.** (Deutsch. Phys. Gesell., Verh. 19. pp. 48–50, March 30, 1919.)—A note on Glocker's equation [Abs. 137 (1917)] $K_K = 3{\cdot}3\,\rho z$—giving the maximum value K_K for the emission of K-radiation by an element of density ρ and atomic number z. The author combines this with a relation, similar to Einstein's, which introduces Planck's quantum. The number of elementary quanta emitted per sec. is calculated. A. B. W.

595. *Calculation of Scattered Radiation from a Plate exposed to a Beam of X-rays.* **O. Klein.** (Phil. Mag. 37. pp. 207–214, Feb., 1919.)—A mathematical paper dealing with the subject in a similar way to that adopted by Glocker [Abs. 946 (1918)]. E. A. O.

596. *Effect of a Magnetic Field on the Fluorescence of Iodine.* **W. Steubing.** (Ann. d. Physik, 58. 1. pp. 55–104, Jan. 17, 1919.)—If iodine vapour is caused to fluoresce between the poles of a powerful electromagnet there may be observed, on excitation of the magnet, a marked increase in the intensity of the fluorescent light, the increase being independent of the way in which the fluorescence is caused. The present paper describes, with many diagrams, a full investigation of this effect. From spectrophotometric measurements it appears that the logarithm of the quantity of fluorescent

light increases proportionally to the strength of the magnetic field. It was also found that the increase in fluorescence is greater in the yellow-green than in the red. The fluorescence change shows no variation with temperature between 15° and 25° C., but the change is greater at 0° C. The effect was found to be greater when an arc light was used to excite the fluorescence than when a 4000-c.p. half-watt projection lamp was employed. Using as excitation source an arc light and also a mercury-vapour lamp, spectrographic measurements showed again that the effect is not uniform throughout the spectrum, and that lines and bands in the region of short wave-lengths are more affected than those of longer wave-length, so that there is an intensity shift when the magnetic field is applied. Structural variation of the band- and resonance-spectra was not observed. The temperature and vapour density have no influence on the magnitude and nature of the magnetic effect, except possibly a secondary effect due to absorption. A. W.

RADIO-ACTIVITY.

597. *Mining and Concentration of Carnotite Ores.* **K. L. Kithil** and **J. A. Davis.** (Bureau of Mines, Bull. 103. [88 pp.] Washington, 1917.)—The information given in this monograph includes a calculation of the cost of concentration of ore for the U.S. National Radium Institute. This works out at $1·44 per lb. of U_3O_8, or $84·29 per ton of concentrates. The cost of the complete mill was $10,000. L. H. W.

598. *Structure of Radio-active Elements.* **I. W. D. Hackh.** (Phys. Rev. 13. pp. 165–170, March, 1919.)—In further developing the periodic system of the chemical elements [see Abs. 1197 (1918)] the author has devised a scheme for the series of the radio-active elements, by which the change in their relative e.m.f. and valency during the different stages of disintegration is brought into harmony with the total charge of the respective substance. The scheme not only offers proof of the completeness of the uranium-radium series, but also points to a theory of "metastasic" electrons, and incidentally establishes, temporarily, structure formula and logical symbols for the radio-active substances. The structure formulæ deduced by the author indicate the atomic weight, the valency or place in the periodic system and the respective position in the uranium, radium, or thorium series. In the theory of metastasic electrons, (*a*) alpha-radiation or the emission of a helium-nucleus causes the change of position of two electrons from the valency ring to the interior unstable ring, (*b*) β-radiation or the emission of an electron causes the shift of another electron from the inner or unstable ring to the outer or valency ring. A. B. W.

599. *The Problem of Radio-active Lead.* **T. W. Richards.** (Nature, 103. pp. 74–78, March 27, and pp. 93–96, April 3, 1919. Presidential address to the Am. Assoc. for Advancement of Science, Baltimore, Dec., 1918.)—The question of the isotopes of lead is approached through a general discussion of radio-active disintegration and recent changes in our conceptions of "atoms" and "elements." It is shown how important it is to study the properties of lead obtained from different sources—especially to compare "radio-active lead" with "ordinary" lead. The results of the more important investigations on the atomic weight, density, etc., of various kinds of lead are collected and critically examined. Comparing the hypothetical value 206·07 for the atomic weight of lead derived from uranium or radium (*i.e.* allowing for decrease of atomic weight due to emission of α-particles) with the observed value 206·08 for uranium lead it is seen that the agreement is remarkably good. This is, perhaps, the most successful attempt on record to compute an atomic weight from hypothetical assumptions. The value 206·08 for the atomic weight of lead has further support in the fact that it is more nearly half-way between thallium 204 and bismuth 208, than is the atomic weight 207·2 possessed by ordinary lead. This latter type of lead, constituting the vast bulk of the lead in the world, has without doubt a much higher atomic weight (207·2) than uranium lead (206). The following comparative table is interesting in relation to the properties of different kinds of lead.

Property.	Common Lead. A.	Mixture (Australian). B.	Uranio-lead. C.	Percentage Difference. A-B.	A-C.
Atomic weight	207·19	206·34	206·08	0·42	0·54
Density	11·337	11·280	11·273	0·42	0·56
Atomic volume	18·277	18·278	18·281	0·01	0·02
Melting-point (absolute)	600·53	600·59	—	0·01	—
Solubility (metal as nitrate)	37·281	37·130	—	0·41	—
Refractive Index (of nitrate)	1·7815	1·7814	—	0·01	—
Thermoelectric effect	—	—	—	0·00	—
Spectrum wave-length	—	—	—	0·00	0·00

The origin of ordinary lead is one of the most difficult questions to answer. It may be either a pure substance or a mixture of uranium-lead with lead of yet higher atomic weight, perhaps 208. The latter substance may be formed, as Soddy points out, if thorium (over 232) lost six atoms of helium, and he and Hönigschmid have found quantitive evidence of its existence in thorium minerals. Other possibilities are suggested but, as the author justly remarks, "the true answers to these questions are not to be found by speculation such as that just detailed . . . they are to be found by careful observation." A. B. W.

HEAT.

600. *Influence of Pressure on Thermal Conductivity of Metals.* **S. Lussana.** (N. Cimento, 15. pp. 130–170, March–April, 1918.)—As a general rule the thermal conductivity increases with the pressure; even where there is a diminution this tends to disappear and in some cases becomes an increase, such increase tending to a maximum; but the results do not support an unqualified application to electrons of the laws relating to perfect gases. A. D.

601. *Silicate Specific Heats.* **W. P. White.** (Am. J. Sci. 47. pp. 1–43, Jan., 1919.)—This is an extension of work previously published, greater accuracy being also aimed at [see Abs. 2078 (1909), 80 (1915)]. The original paper should be consulted for details, it being impossible here to do more than reproduce the author's summary of results.

The specific heats of various silicates and forms of silica have been determined for upper temperatures from 100° to 1400° C. The method was by dropping from furnaces into calorimeters. Two apparently new methods are described for determining true or atomic heats from interval heats.

On the whole, the general temperature variation of the specific heats is one depending mainly upon the value of ν, an atomic vibration period, assignable to oxygen in combination. Several forms of silica, whose expansion is very small, and which therefore practically give values of specific heat at constant volume, C_v, show that C_v for high temperatures appears to exceed the theoretical value 5·96. Glasses show, in the main, a specific heat only slightly above the corresponding crystal forms, but with a tendency to increase at some rather high temperature. In several sets of polymorphic forms with sluggish inversions there were differences of about 2 % between the two forms, but none of these forms showed any variation in specific heat near the inversion temperature. In quartz, below the α-β inversion at 575°, the heat absorption is much less than corresponds to the abnormal expansion. If such anomalous absorption, unusual change of volume, and change of crystal properties are each or all together the sign of a change of state, then quartz undergoes a gradual change of state over an interval of 400 deg. below what is commonly called its α-β inversion. Quartz (and probably other forms of silica) exhibits what appear to be two kinds of inversion, due to different mechanisms.

Some of these facts militate against certain hypotheses which make polymorphism the resultant of continuous polymeric or isomeric changes in the solid. L. H. W.

602. *Specific-heat Determination at Higher Temperatures.* **W. P. White.** (Am. J. Sci. 47. pp. 44–59, Jan., 1919.)—Deals with the experimental technique of specific heat determination at temperatures up to 1400° C. by the "method of mixtures." Modifications in furnaces and in methods of transferring to the calorimeter are described in detail. The variability of the heat losses attending the dropping of hot bodies into water proved to be surprisingly great; the prevention of such losses is probably advisable in accurate work, perhaps by the use of aneroid calorimeters. L. H. W.

603. *The Specific Heat of Aqueous Solutions, with Special Reference to Sodium and Potassium Chlorides.* **W. R. Bousfield** and **C. E[lspeth] Bousfield.** (Roy. Soc., Phil. Trans. 218. pp. 119–156, Feb. 25, 1919.)—The authors have investigated the specific heat of solutions of potassium and sodium chlorides at the mean temperatures of 7°, 20°, and 32°. The method and apparatus employed were essentially the same as those described previously by the authors [Phil. Trans. A. 211, 199 (1911)], although modifications of the apparatus have been introduced. For KCl solutions the values of the mean specific heats at 7° range from 3·206 to 4·193 for values of h ranging from 16·362 to ∞ ($h =$ number of molecules of water per gm.-mol. of solute. For NaCl solutions the corresponding values are 3·292 to 4·193 for h 9·7367 to ∞.

On comparing the values of the specific heat with the density, it is found that there is a linear relationship between ϕ, the difference between the volume of the solution containing the gm. molecular weight of the solute and the volume of the original water, and ψ, the corresponding function, substituting specific heat for specific volume. This linear relationship the authors believe to be capable of a definite rational interpretation. In the case of volume-changes in the solution, the solid solute, on being dissolved, is regarded as passing into the liquid state, whereby a certain change of volume occurs. The volume of the liquid solute is, however, believed not to alter on dilution, so that the contraction which takes place on isothermal dilution may be ascribed wholly to changes in the water. Similarly, the specific heat of the liquid solute may, as the authors show, be taken as constant for all dilutions, and the experimental results may then be interpreted as showing that the lowering of the mean specific heat of the water is proportional to the mean specific contraction of the water. The authors also derive the following relationship between heat of dilution and contraction: $(dQ/dt)_H = L(d\chi/dH)_h$, where Q is the mean heat of dilution per gm. of added water, and $d\chi/dH$ the contraction which takes place when 1 gm. of water is added to an infinite quantity of the solution. The authors also show that their results appear to justify the hypothesis that the specific heat lowering and the specific volume lowering of the free water may without serious error be taken as proportional to the percentage concentration, with the corollary that the specific heat and specific volume of the liquid solute may be treated as constant for all dilutions, and also the specific heat and specific volume of the combined water with perhaps somewhat less accuracy. A. F.

604. *Incandescence-Electrons. The Entropy-constant of Incandescence-Electrons.* **M. v. Laue.** (Jahrb. d. Radioakt. 15. 3. pp. 205–256, and pp. 256–270, Nov. 28, 1918.)—The electrons emitted by an incandescent electrode form in the state of equilibrium a layer which, in the absence of intense external disturbances, possesses an energy, entropy and a charge per unit surface determined by the temperature and the material of the electrode. The surface tension in this layer is negative, of the nature of a surface pressure; and the capillary pressure on curved surfaces hence negative. The electronic density at the boundary in immediate contact with the electrode surface—and therefore also the energy, entropy and charge—is, as function of the temperature, determined by the position of the electrode in the voltaic series and by a universal chemical constant C of the layer of electrons; the formula agrees with Richardson's equation. When the dimensions of a

hollow space, completely enclosed by electrodes of the same temperature, are uniformly enlarged, the electronic density in the interior will decrease, whilst it remains unchanged at the boundary. The relative accumulation of electrons on the surface becomes more pronounced with rising temperature. Some authors speak of an electron-gas obeying the ideal gas laws. But as long as the electrons remain in thermodyamic equilibrium with the incandescent electrode, they do not at all approach the ideal state with rising temperature. Yet the conception of an electron-gas is well justified, provided it be restricted to a layer of electrons of a constant number of electrons; this point is further dealt with in the second paper. As long, however, as there is an electrode capable of supplying more electrons, when the temperature is raised, the analogy of the ideal gas is open to objections. This consideration does not affect the view that the electrons behave like a gas in a metal; the presence of positive charges of the atoms would alone suffice to alter the conditions. The author's formula for the electronic density ρ_g at the boundary is $\rho_g = (N\epsilon)^3 . C^2 . T^{3/2} e^{\mu/RT}/2R$, where N is the number of molecules per mol, ϵ the electronic charge, R the gas constant, and μ the electronic affinity of the electrode material, *i.e.* μ represents the work to be done when one mol of electrons is withdrawn from the electrode at constant temperature. The formulæ are only approximate. H. B.

605. *Electronic-vapour Pressure and the Clausius-Clapeyron Equation.* **W. Schottky.** (Phys. Zeits. 20. pp. 49–51, Feb. 1, 1919.)—Comments on Laue's papers [see preceding Abs.]. Laue considers (1) that his equation for ρ_g differs from the Clausius-Clapeyron equation and that hence electrons cannot be regarded as an ideal gas; further (2), that his own equation holds only under the assumptions that the electric field intensity at the surface of the metal has a definite value, and that the so-called electric formation-force does not affect the field and the kinetic energy of the electron; and finally (3) that the energy and entropy of the electron cannot be calculated as for ordinary gases. The author points out that with these objections of Laue the clearness of the present view on electronic vapours would vanish. He shows, however, that the objections are unfounded; that the difference between Laue's formula and that of Clausius-Clapeyron and Wilson is merely formal; that the restrictions of (2) may be disregarded, and that hence (3) electrons may be treated as an ideal gas. The paper is a preliminary note; full mathematical deduction is reserved. H. B.

606. *Mechanical Equivalent of Heat.* **L. Décombe.** (Comptes Rendus, 168. pp. 268–271, Feb. 3, 1919.)—A note showing how certain numerical values, given by Carnot in his original memoirs on the mechanical equivalent of heat, may be calculated from simple data. A. W.

607. *Laws of Perfect Gases and the Theory of Heat.* **M. Ascoli.** (N. Cimento, 15. pp. 212–220, May–June, 1918.)—The equations $pv^{\gamma} = \text{const.}$, $\gamma = \text{const.}$, $pv = R\tau$, and $dH = c_p . \partial\tau/\partial p . dv + c_v . \partial\tau/\partial v . dv$ are consistent with either the caloric theory or the thermodynamic theory; but for the caloric theory dH must be a perfect differential, for the thermodynamic theory not. In the caloric theory the equation $\gamma = \text{const.}$ implies that C_p and C_v shall be different according to any of an infinite number of laws; in the thermodynamic theory there is no such implication. The fact that C_p and C_v do not differ rules out the caloric theory. The condition that dH is not a perfect differential is necessary for the thermodynamic theory of heat but is not conclusive as to it; there might be an infinite number of hypotheses. What is required to make it conclusive is the addition of the two conditions that the difference $dH - Apdv$ shall be a perfect differential, and that A shall be a constant the same for all substances. A. D.

608. *Derivation of the Quanta Hypothesis for Entropy without Recourse to the Stirling Formula.* **K. Lichtenecker.** (Phys. Zeits. 20. pp. 12–14, Jan. 1, 1919.)—The hypothesis for the entropy of a system of N homogeneous elements (molecules, atoms) has already been derived as a logarithmic function of the thermodynamic probability of its state by making use of the known Stirling approximation formula. The present paper shows how the entropy may be determined in a simple manner by means of the quanta theory alone. Starting from the case of equal probability for elements of given state, the expression evolved is generalised for different probabilities. H. H. Ho.

609. *On a Quanta Theory of Absorption.* **W. Kasperowicz.** (Deutsch. Phys. Gesell., Verh. 20. pp. 110–112, Aug. 30, 1918.)—An application of the quanta theory to the case of absorption has not yet been made wholly free from objection, so that at present the quanta theory only holds good for emission. In this paper it is shown that a quanta theory for absorption is possible if suitable fundamentals are chosen. Preliminary work has already been published by the author towards the construction of an impact theory of radiation, which latter he develops by an investigation of the impact phenomena between elements of the radiating body. Corresponding to this arises an impact theory of absorption, whereby a definite connection with a quanta theory of absorption ensues. The quantum element, $\epsilon = h\nu$, is given by the electronic molecular relations, and is essentially an emission quantum. On the other hand, the absorption quantum is conditioned by the interaction between a radiation field and an absorption system, and must on this account be much smaller than the emission quantum. A distinction is thus made between an emission quantum ϵ_e and an absorption quantum ϵ_a. By means of this assumption the author then develops a quanta theory for absorption and radiation. When a quanta structure is postulated for the radiation field, absorption can take place by sub-quanta according to the probability function, whereby the energy quanta ϵ_s of the radiation field may be equal to the absorption sub-quanta ϵ_a. A further paper is promised for the application limits of such a quanta absorption theory. H. H. Ho.

610. *Application to Eight different Substances of the Formula expressing the Heat of Vaporisation of a Liquid.* **E. Ariès.** (Comptes Rendus, 168. pp. 444–447, March 3, 1919.)—The author's formula for the heat of vaporisation of a liquid [see Abs. 463 (1919)], is now applied to eight different substances in the order of their atomicity, namely: carbon dioxide, ammonia, stannic chloride, methyl formate, pentane, hexane, heptane, and octane. The tensions of the saturated vapours of these bodies have been the subject of many previous studies [Abs. 853, 1174, and 1175 (1918)] for the determination of their degrees of atomicity. It is shown that the temperature and the critical pressure, which are fundamental data, in conjunction with the exponent n and the function Γ, define not only the saturated vapour-tension of a body but also its molecular heat of vaporisation L, without recourse to any other factor. The experimental data are taken from the "Recueil des Constantes physiques" for carbon dioxide (Chappuis and Mathias, p. 326) and for ammonia (Schnerr and Strombeck, p. 325), and for the other substances from Young's Memoirs [Roy. Dub. Soc., Proc. 1910]. Excellent agreement is found between the calculated and the observed results, which are tabulated in the paper. H. H. Ho.

611. *On the Quanta Hypothesis of Sommerfeld and Epstein.* **A. Einstein.** (Deutsch. Phys. Gesell., Verh. 19. pp. 82–92, May 30, 1917.)—In conjunction with this paper Abs. 654 (1917) should be consulted. Section 1 deals with previous formulation. Therein it is stated that no doubt now exists that for periodic mechanical systems having one degree of freedom the quantum condition of Sommerfeld holds, namely: $\int p dq = \int p \, . \, dq/dt \, . \, dt = nh$. Here the integral is taken over a whole period of motion, q denotes the coordinate, p the corresponding impulse coordinate. Further, the spectral work of Sommerfeld shows that for systems having several degrees of freedom, a corresponding quanta condition holds, namely: $\int p_i dq_i = n_i h$. Since this formulation is not independent of the coordinates, a definite choice of these must be taken. Epstein has founded his rule for the selection of the Sommerfeld coordinates q_i upon Jacobi's theorem which is discussed at length. Although the Sommerfeld-Epstein extension of the quanta hypothesis to systems having several degrees of freedom has met with great success, yet the separation of the variables is its unsatisfactory feature. In the present paper, therefore, a slight modification is proposed for remedying this defect. In section 2 an alteration in formulation is suggested whereby the quanta condition becomes invariant. In section 3 the Hamilton-Jacobian differential equation is derived. Section 4 deals with the p_i field of a single orbit. In section 5 the rational coordinate space is discussed.

The paper is mathematical throughout. H. H. Ho.

SOUND.

612. *Vowels.* **K. v. Wesendonk.** (Deutsch. Phys. Gesell., Verh. 19. pp. 95–108, June 30, 1917.)—Discusses the work of D. C. Miller with the phonodeik, that of Scripture and the author's own synthesis of the vowels. [See Abs. 1424 (1909) and 995 (1917).] E. H. B.

613. *Asymmetrical Vibrations.* **E. Budde.** (Deutsch. Phys. Gesell., Verh. 20. pp. 253–260, Dec. 30, 1918.)—A mathematical discussion of the vibrations of a point under asymmetrical constraints. E. H. B.

614. *Resonance Theory of Audition.* **E. Budde.** (Deutsch. Phys. Gesell., Verh. 19. pp. 22–40, Feb. 28, 1917.)—Following up a previous paper on this subject the author now discusses the Corti organs in the ears of mammals, also the basilar membrane and the hairlets. The paper also treats the topic as to whether there is present any arrangement to neutralise, entirely or partially, the *unsharpness* of resonance. [See also Abs. 996 and 1292 (1917).] E. H. B.

615. *Method of Comparing Tuning-Forks of Low Frequency and of Determining their Damping Decrements.* **A. Campbell.** (Phys. Soc., Proc. 31. pp. 87–89; Disc., 89, Feb. 15, 1919.)—The method consists in putting the windings of the maintaining magnets in series with each other and with a sensitive vibration galvanometer. The beats are clearly shown by the pulsations of the band of light on the scale. E. H. B.

616. *New Determination of Speed of Sound in Free Air.* **E. Esclangon.** (Comptes Rendus, 168. pp. 165–167, Jan. 20, 1919.)—The sound-waves from guns of various calibre were received by electro-acoustic detectors at 1400 m. and 14,000 m. along the same line. The times were evaluated to about one five-hundredth of a second. The experiments were made in 1917 and 1918 at temperatures from 0° to 20° and under various conditions as to wind and humidity. The final result for the speed of sound in dry air at 15° is 339·9 m./sec. which is compared with Regnault's value for calm air, 339·7 m./sec. E. H. B.

617. *Forced Vibrations and their Significance.* **G. Duffing.** (Sammlung Vieweg, Nos. 41 and 42, Brunswick, 1918. Elektrot. u. Maschinenbau, 36. pp. 532–533, Dec. 8, 1918. Abstract.)—A short discussion of the subject with quotation of the differential equations of motion of systems, with restoring forces proportional to the first, second, and third powers of the displacement. E. H. B.

618. *Sound-Intensity Measurements by the Baretter.* **B. Gáti.** (Elektrot. u. Maschinenbau, 36. pp. 527–528, Dec. 15, 1918.)—Describes by reference to a diagram a method of estimating, by use of the baretter, the intensity of the sound from an aeroplane engine. This method is designed to facilitate the silencing of such motors as far as possible. E. H. B.

619. *Low-frequency Microphone Hummers.* **A. Campbell.** (Phys. Soc., Proc. 31. p. 84, Feb. 15, 1919.)—This note describes the conditions of

mechanical loading, capacitance, and position which the author has found will give successful working at low frequencies. E. H. B.

620. *Simple Tuning-fork Generator for Sine-wave Alternating Current.* **A. Campbell.** (Phys. Soc., Proc. 31. pp. 85–86, Feb. 15, 1919.)—The arrangement consists of an electrically maintained tuning-fork, to one prong of which is attached a small, thin coil with its axis perpendicular to the direction of motion of the prong. As the fork vibrates, the coil oscillates in the field of a fixed horseshoe magnet and an approximately sinusoidal e.m.f. is set up in the coil. The frequency with the apparatus shown was 10 per sec. E. H. B.

621. *Mechanical "Resonators" under Double Forcing.* **E. H. Barton** and **H. M. Browning.** (Phil. Mag. 37. pp. 453–455, April, 1919.)—Twenty "resonators" of graduated periods were made as pendulums with small white-paper cones as bobs and black threads as suspensions. These cones were used alone for the first set of six photographs and afterwards with a ring of copper-wire on each to lessen the damping for the subsequent eighteen photographs. Their logarithmic decrements in the two states were of the order 0·1 and 0·025 per half-wave, but varied slightly from end to end of the system. These twenty "resonators" were suspended near one end A of a horizontal tightly-stretched cord AB from the middle of which a pendulum with heavy bob was also suspended to act as driver or forcer of the vibrations of the "resonators." From A another horizontal cord started with its other end near B, and from near the middle of this cord a second driving pendulum or forcer was hung with bob equal to that of the first driver. Near the "resonators" the two cords were connected by a light wooden bridge, so that each driver could impress its motions on the "resonators" although the two drivers were almost independent of each other. Thus when the two drivers are properly adjusted to distinctly different lengths, but both well within the range of the "resonators," the latter are excited and show two places of max. response with gradual falling off of amplitude above and below each. Moreover, at and near each maximum the frequency of the responders is that of the corresponding driver. These effects are shown in the paper by a time exposure and five flash photographs.

In the next set of six photographs the rings are in use on the paper cones, the damping is much less and the "resonance" is consequently seen to be much sharper as theory predicts. This increased sharpness of resonance suggested pushing the periods of the two drivers nearer to equality with the view of noting how closely two maxima of "resonance" could occur and yet be detected without coalescence of behaviour on the part of the responders. The results are shown in the next six photographs, the nearness of period being pushed to equality. Six other photographs are given to show the power of discrimination of a set of "resonators" as to the frequency of a single driver in use, and it is seen that the discrimination possessed by such responders is much finer than that of the difference of frequencies of the successive responders themselves. This has an important bearing on the adequacy of the provisions in the human ear to fulfil the requirements of the resonance theory of audition to which reference is promised in a future paper. [See Abs. 1140 (1918).] E. H. B.

622. *Vibrations of Elastic Shells partly filled with Liquid.* **S. Banerji.** (Phys. Rev. 13. pp. 171–188, March, 1919.)—The problem considered in this

paper is chiefly of acoustical interest in relation to the theory of "musical glasses." This class of instrument consists of a series of thin-walled elastic shells whose gravest modes of vibration are tuned to form a musical scale by partially filling them with a liquid, and are excited either by striking or by tangential friction on the rims. The principal features of interest requiring elucidation are: (1) the dependence of the pitch of the vibration upon the quantity of liquid contained in the vessel, and (2) the mode of vibration of the liquid itself. These features are discussed in this paper for the three cases in which the elastic shell is respectively (*a*) a hemispherical shell, (*b*) a cylindrical vessel with a flat bottom, and (*c*) a conical cup. The analytical expressions show that the motion of the liquid is very marked near the margin of the vessel, and is almost imperceptible near the centre and also at some depth inside the liquid. Numerical results have been obtained and tabulated showing the theoretical relation between quantity of liquid and vibration frequency, and graphs are also plotted. E. H. B.

623. *Unsymmetrical Vibrations of a Loaded Membrane.* **E. Waetzmann** and **W. Moser.** (Deutsch. Phys. Gesell., Verh. **19.** pp. 13–18, Feb. 28, 1917.)—The vibrations of an india-rubber membrane (which at one place is strongly loaded asymmetrically) are photographed, and some of the resulting asymmetrical curves reproduced in the paper. In one case the membrane was under double forcing from primary tones of frequencies p and q, 700 and 250 respectively, and gave responses of amplitudes about 1, 0·7, and 0·3 respectively for the tones p and q and the difference tone $p-q$. The details of the experiment and the quantitative theory are to be given later. [See Abs. 294 (1914).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

624. *Einstein's Theory and Electrostatic Laws.* **C[arlotta] Longo.** (N. Cimento, 15. pp. 191–211, May–June, 1918.)—Works out the fundamental laws of electrostatics from Einsteinian postulates. Shows that there ought to be a mechanical force exerted by a charge upon a unit of material mass; if it were possible to verify its existence, it would support Einstein's theory.

A. D.

625. *Temperature Dependence of the Dielectric Constant of Certain Gases and Vapours.* **M. Jona.** (Phys. Zeits. 20. pp. 14–21, Jan. 1, 1919.)—P. Debye has already shown that the temperature dependence of the dielectric constants of insulators can be explained on the classical statistical theory, by the assumption of the existence of dipoles. The experimental data from a series of substances have also been found inexplicable on the single assumption of oscillating particles. The present paper contains an extension of work already published by Lange on the connection between dielectric behaviour and molecular association of certain liquids, and by Bädeker on an experimental investigation of the temperature dependence of the dielectric constants for certain gases and vapours. Debye's theory, which is here verified, gives the expression $8\varepsilon - 1 \surd \varepsilon + 2 = \frac{4}{3}\pi N_0 \left\{ \frac{\Sigma n_i e_i}{fi} + \frac{u^2}{3kT} \right\}$, where ε is the dielectric constant, N_0 the number of molecules per cm.^{3}, k the Boltzmann constant ($k = 1{\cdot}35 \times 10^{-16}$ erg), T the absolute temperature, and u the fixed moment of every molecule. Each molecule consists of n_i charges e_i, which are connected to their rest position by a force fi. The principle of measurement adopted rests upon the assumption that the Clausius-Mossot expression holds, namely: $(\varepsilon_1 - 1)(\varepsilon_2 - 1) = \rho_1 \rho_2$, where ρ_1 and ρ_2 are the densities corresponding to the dielectric constants ε_1 and ε_2. Full experimental details are given, including methods of eliminating errors. Tables of results with accompanying discussion are given for air, carbon dioxide, ammonia, sulphur dioxide, methyl alcohol, and water-vapour. A mathematical criticism of the data curves concludes the paper.

H. H. Ho.

DISCHARGE AND OSCILLATIONS.

626. *Ionising Power of the Positive Ions from a Glowing Tantalum Filament in Helium.* **F. Horton** and **[Miss] A. C. Davies.** (Roy. Soc., Proc. 95. pp. 333–353, March 15, 1919.)—The authors have for some time being conducting experiments involving the ionisation of helium gas by collisions, and in the course of this work were led to make a direct investigation of the ionising power of the positive ions emitted by a glowing tantalum filament. An account of this investigation is given in the present paper. The results obtained lead to the conclusion that the minimum ionising potential for positive ions is very much greater than that for electrons. The positive ions from a glowing tantalum filament do not ionise helium when they collide with the gas atoms with velocities up to 200 volts, but it is found that they liberate electrons from a negatively charged platinum surface when they

bombard it with velocities greater than about 20 volts. [See Abs. 933 and 1710 (1914).] A. W.

627. *Amplification of Photoelectric Current.* **C. E. Pike.** (Phys. Rev. 12. pp. 102–108, Feb., 1919.)—Describes a method of amplifying photoelectric currents by means of the audion valve. The amplification may be from 1600 to 5000 times. The weaker the light the smaller the primary photoelectric current and the larger the amplification. With certain valves amplifications up to 18,000 times have been obtained. A. W.

628. *Emission and Absorption of Electrons by Platinum and Silver.* **O. Stuhlmann, Jr.** (Phys. Rev. 13. pp. 109–133, Feb., 1919. Paper read before the Am. Phys. Soc., Dec. 27, 1917.)—Describes research on the properties of thin, wedge-shaped films of Pt and Ag. The films were obtained by the "evaporation" of a Pt or Ag wire *in vacuo.* The chief interest of the paper lies in the full description of the apparatus and methods employed, and in the diagrams and tables of results, for which the original paper should be consulted. A. W.

629. *A Solarisation Method of measuring Scattering of Canal Rays.* **M. Wolfke.** (Deutsch. Phys. Gesell., Verh. 19. pp. 111–115, July 30, 1917.) —It is first shown how the solarisation method can be employed in a simple manner for obtaining exact measurements of the scattering of canal rays. As an example two curves illustrating scattering are given, one from results obtained by the author, the other from those of Retschinsky. These show a very slight scattering of the canal rays. It is suggested that the reversal of solarisation by canal-ray images could be used for the same purpose and one instance of this is given. In this case it is shown that four times as much energy is required in the reversal of solarisation as is necessary to cause the latter. A. E. G.

630. *Pressure Difference in D.C. Discharge Tubes.* **F. Skaupy.** (Deutsch. Phys. Gesell., Verh. 19. pp. 264–267, Nov. 30, 1917.)—Stark found, in the case of the d.c. discharge through nitrogen, a higher pressure at the kathode than at the anode. The present paper gives a brief description of experiments which show that with the rare gases (He, etc.) at low pressure the discharge also gives rise to pressure differences, which are of the same order of magnitude as the pressure existing in the discharge tube. But in this case the higher pressure is to be found at the anode. The explanation of this effect is possibly to be found in the existence of negative moleculions, which may move considerably faster than the positive ions. A. W.

631. *Explanation of the Hittorf Kathodic Dark Space.* **R. Holm** and **T. Krüger.** (Phys. Zeits. 20. pp. 1–5, Jan. 1, 1919.)—The object of this paper is to endeavour to prove experimentally the theory put forward by Holm [Abs. 1311 (1915) and 331 (1919)] relative to the Hittorf dark space. According to this theory the light emitted by an ionisation region depends not only on the number of collisions and the velocity of the colliding electrons or ions, but also on the strength of the electric field. If at any point the field is so strong as to hinder the recombination of the electrons and ions the light emitted is diminished and a dark space results. It is not supposed that these experiments prove the Holm theory, but it is claimed they give additional evidence in its support. Tables and a plate showing the results obtained are given. A. E. G.

632. *Theory of Pliotron Oscillator.* **T. Kikuchi.** (Phys.-Math. Soc. Japan, Proc. 1. pp. 14–29, Feb., 1919.)—A mathematical treatment in which is considered the amplitude of the steady undamped oscillation from a three-electrode valve. The treatment follows up the work of Hazeltine [Abs. 465B (1918)]. The present paper does not admit of brief abstract. [See Abs. 980B (1915).] A. W.

633. *Absorption of Electric Waves along Parallel Wires.* **W. Arkadief.** (Ann. d. Physik, 58. 2. pp. 105–138, Feb. 4, 1919.)—Along two parallel wires damped electric waves of 72·7 cm. to 1·27 cm. wave-length were received. It was shown that in consequence of the absorption the energy of the waves diminished according to the exponential law. A theoretical value (γ) of the absorption coefficient was calculated. The experimentally found value (γ') for non-magnetic wires was 3·3 % greater than the above. The decrement of the absorption coefficient of magnetic wires showed in the region investigated a rapid fall of permeability for short waves. The permeability, reckoned from the absorption coefficient, for wave-lengths of 72·7 cm. was found to be 98 for soft Swedish iron and 20 for nickel wire. For wave-lengths of 1·31 cm. the max. permeability of iron was 8 and of nickel was practically unity. By extrapolation it appeared that for wave-lengths of a few mm. the permeability of iron would be practically unity. [See Abs. 2027 1900).]. E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

634. *Resistanceless Electric Circuits.* **G. Lippmann.** (Comptes Rendus, 168. pp. 73–78, Jan. 13, 1919.)—The author points out that from the analytical standpoint electrical resistance may be considered as the analogue of friction in mechanical problems, both masking general laws by the introduction of coefficients depending on the physico-chemical character of the materials in question. And the experiments of Onnes show that the electric resistivities of metals, after decreasing gradually with falling temperatures down to about that at which helium liquefies, then suddenly fall to about 10^{-10} of their amount above this critical point, and so provide experimental support for assuming the existence of conductors having no resistance. Moreover, this assumption is found experimentally applicable to Leyden-jar phenomena, formulating their theory in the simplest and most exact form. Suppose a circuit of resistance R to move in a magnetic field, generating an e.m.f. $E = dN/dt$ and a current C. Let the resulting e.m.f. due to the self-induction of the circuit be $E' = dN'/dt$. Then $CR = dN/dt + dN'/dt$, and for $R = 0$, we have $\Delta N + \Delta N' =$ constant and $N + N' =$ constant, so that the total effect is as if the hyper-conducting circuit were impermeable to the lines of force. This explains Onnes' experiment in which he showed that when a closed coil at rest between the poles of an electromagnet was immersed in liquid helium, and the magnet removed, a constant current continued in the hyper-conducting coils, and corresponding results were obtained when the coil was replaced by a solid or hollow conductor. It also explains his experiments showing that the well-known viscous resistance of a magnetic field to the introduction into it of a metallic conductor became transformed into an elastic resistance if the conductor were in the hyper-conducting state. The fact that any metallic conductor acts as a practically perfect reflector to Hertzian waves is accounted for by the fact that in this case, owing to the rapidity of the oscillations, the resistance is negligible in comparison with the terms dN/dt and dN'/dt. G. W. DE T.

635. *Double Induction Balance for Corbino's Effect* (1911). **L. Puccianti.** (N. Cimento, 15. pp. 249–257, May–June, 1918.) A. D.

636. *Relation between the Electrical Conductivity and the Periodic System of the Elements.* **E. Grüneisen.** (Deutsch. Phys. Gesell., Verh. 20. pp. 58–62, April 30, 1918.)—The author briefly reviews the method by which Benedicks has sought to correlate the resistivity of an element with other physical properties of the atom. Benedicks, defining the atomic conductivity (Λ) as the product of the specific electrical conductivity and the atomic volume (v) writes this quantity equal to $C\nu$. ν is the frequency of the atom and C a factor termed the "electrical conductivity capacity." It expresses, in accordance with the "agglomeration" hypothesis, a greater conductivity when the impacts are more frequent, facilitating the passage of electrons from atom to atom. According to Benedicks, this atomic property C, when represented as a function of the atomic weight, follows the periodic law of the elements. Grüneisen, while acknowledging the importance of this factor C, points out that it involves the resistivity and therefore is dependent on the temperature. Comparisons can only be made when the data used are taken at corresponding temperatures. He expresses the resistivity (w) as

$$v/C \,.\, T/\theta_\gamma \,.\, F(T/\theta_\gamma).$$

In this θ_γ is the characteristic temperature of the element and corresponding temperatures are those for which T/θ_γ is the same. The form of the function F is similar to that in Debye's atomic-heat formula. With data at present available a table is constructed from which he concludes that the atomic conductivity at corresponding temperatures varies periodically with the atomic weight, decreasing from a maximum in Group 1 to a minimum in Group 0 or 8. L. L.

637. *Experiments Demonstrating an Electrical Effect in Vibrating Metals.* **H. B. Jackson** and **G. B. Bryan.** (Roy. Soc., Proc. 95. pp. 366–382, March 15, 1919.)—In a previous paper [Abs. 1276 (1918)] experiments have been described indicating that part of the energy of a vibrating wire gave rise to an e.m.f. This was detected by the response in a suitably connected telephone and was apparently but little affected by the direction of the wire to the earth's magnetic field. The present paper describes a large number of experiments made to elucidate this effect. With two similar steel wires, one maintained bright and the other treated with dilute sulphuric acid, the response of the latter diminished with time, but the decrease was not wholly accounted for by the diminished sectional area of the "rusting" wire. Various metallic rods and tubes were suspended and set in acoustic vibration. By the aid of exploring coils, rectifier and galvanometer circumferential currents were detected. These varied in strength and phase at different positions on the axis of the tube irrespective of its angle with respect to the lines of force of a uniform magnetic field. The primary magnitude of the currents, however, is greater, the greater the inclination of the axis of the tube to the lines of force. Response is not always entirely eliminated when the tube is fixed with its axis parallel to the field. A carbon rod behaved similarly, but other non-metallic rods failed to give any response. Vibrating metallic plates give similar effects, if the nodal lines are regarded as the axes of the vibrating body. Experiments made with the vibrating body under the receiver of an air-pump and the search coil outside showed no change in response when the air pressure was reduced to 0·4 mm. of mercury. The

authors conclude that the effect is due to the motion of the conductor in the earth's magnetic field although there is some residual effect not yet accounted for. L. L.

638. *Resistances of some Pure Insulators at High Temperatures. Thermionic Currents and Dissociation.* **E. Podszus.** (Deutsch. Phys. Gesell., Verh. 19. pp. 231–238, Oct. 30, 1917.)—Rods of the insulators to be investigated were heated in a specially constructed small resistance furnace made of a spiral of tungsten ribbon and contained in a glass bulb which could be evacuated, or filled with nitrogen at one atmosphere pressure. The rods, which were made from the pure materials by binding with a "Zelloidin" cement and then burning at a high temperature, were 10 mm. long and 1·25–1·4 mm. thick. Care was taken to remove all adsorbed gases from the bulb and its contents by heating at 400° for some time whilst evacuating, and then heating the spiral to a high temperature and raising the vacuum to the required amount, 10^{-3} to 3×10^{-4} mm. Hg. In order to avoid the influence of electronic currents from the heating spiral the heating current (alternating current of 5 ∿) was cut off just at the moment of measurement. The extreme results obtained were as follows: Lime, rod 1·25 mm. thick. In vacuum, $2–3 \times 10^{-4}$ mm. Hg: 1510°, 1,330,000 ohms, 1690°, 80,000 ohms; in N_2: 1510°, 210,000 ohms, 1640°, 55,000 ohms. Alumina, rod 1·35 mm. thick. In vacuum, 10^{-3} mm. Hg: 1550°, 3,300,000 ohms, 1775°, 410,000 ohms; in N_2: 1590°, 3,300,000 ohms, 1800°, 290,000 ohms. Magnesia, rod 1·3 mm. thick. In vacuum, 3×10^{-4} mm. Hg: 1610°, 1,250,000 ohms, 1740°, 400,000 ohms; in N_2: 1610°, 580,000 ohms, 1700°, 170,000 ohms. Thoria, rod 1·32 mm. thick. In vacuum, 10^{-3} mm. Hg: 1530°, 500,000 ohms, 1690°, 150,000 ohms; in N_2: 1540°, 250,000 ohms, 1700°, 105,000 ohms. Boron nitride, rod 1·4 mm. thick. In vacuum $2–5 \times 10^{-3}$ mm. Hg: 1680°, 700,000 ohms, 1840°, 100,000 ohms; in N_2: 1520°, 10,000,000 ohms, 1930°, 230,000 ohms.

The results show that boron nitride is the best insulator at high temperatures. The conductivity for chemically related substances runs parallel with the extent of their dissociation at high temperatures. With the exception of alumina the resistances of the oxides is less in an atmosphere of nitrogen than in a vacuum, probably because of chemical reaction taking place. The higher resistance of boron nitride in nitrogen is due to the suppression of the dissociation of the former. Some special measurements on titanium nitride at 1000°–1435° showed that its resistance was also slightly greater in an atmosphere of nitrogen, but this difference may be due to thermionic currents, which are very noticeable in this case.

Preliminary measurements with tungsten, molybdenum, platinum, and iron indicated that there is a definite relation between vaporisation and electronic currents, tungsten giving the least, and iron the largest currents. T. S. P.

639. *Measurement of Peak Potential of an Alternating Source.* **C. C. Paterson** and **N. Campbell.** (Phil. Mag. 37. pp. 301–303, March, 1919. Electrician, 82. p. 514, May 2, 1919. Abstract.)—A method is outlined in which the peak potential is obtained by using a two-electrode thermionic valve and an electrostatic voltmeter, the latter being in parallel with a condenser of relatively large capacity. The conditions necessary to obtain accurate results are discussed. N. W. M

640. *Electrical Resistance of Hardened Steel.* **E. D. Campbell.** (Iron and Steel Inst., J. 98. pp. 421–426, 1918. Abstracts in: Electrician,

82. pp. 17–18, Jan. 3, 1919. Engineering, 106. p. 509, Nov. 1, 1918.)—Some of the steels used in a former research [Abs. 197 (1918)] have been subjected to special thermal treatment and their specific resistances redetermined with the object of providing data to indicate the influence of temperature on the rate of reaction in the unstable solid solutions of which these steels are composed. After quenching and measuring the resistance the specimen was placed for one hour in an oven at 100° C. and the resistance again determined. This reheating at 100° C. was repeated for varying intervals up to 12 hours, the resistance being measured after each heating. Table I is a summary of the data obtained.

TABLE I.

Carbon, %	0·57	0·76	0·945	1·05
Resistivity (microhms) quenched from 907° C.	21·88	32·24	36·32	39·73
Resistivity on tempering for 1 hr. at 100° C.	20·67	27·47	29·62	32·97
Resistivity after tempering for 12 hrs. at 100° C.	19·87	25·75	27·31	29·19

The resistivity of other quenched samples was measured at definite times after standing at room temperature, the observations extending over a period of two years. Table II is a summary of the chief data.

TABLE II.

Carbon, %	0·57	0·76	0·945	1·05
Resistivity when quenched from 906° C.	21·07	32·64	35·85	40·00
Resistivity after standing 7 days at room temperature	21·17	32·48	38·53	39·87
After 4 months	20·84	31·05	33·70	37·76
After 12 months	20·87	30·83	33·24	37·27
After 2 years	20·60	30·33	32·53	36·47

L. L.

641. *A New Quartz-tube Mercury-vapour Lamp.* **M. Wolfke.** (Deutsch. Phys. Gesell., Verh. 19. pp. 239–240, Oct. 30, 1917.)—Ordinary quartz-tube mercury-vapour lamps for laboratory use have the drawback that the tube is horizontal, whereas light entering a vertical slit is required for most optical work. Metal vanes are used to dissipate the heat and the action is somewhat irregular. The new lamp has a vertical tube, either in the form of a ring or an inverted "U." No capillary action is needed for regulation. The electrodes are both sealed into the same support, thus distributing the heat uniformly at the anode and kathode and maintaining the level of mercury automatically. This gives steadier running and the lamp is less susceptible to variation in p.d. The part enclosing electrodes is surrounded by a metal cup through which water percolates. The lamp takes 2–10 amps. according to the conditions of cooling. Curves are presented, with p.d. as ordinate and current as abscissa. The curve is almost vertical with no cooling but becomes more inclined with water-cooling and ultimately may become nearly

horizontal. The max. c.p. attainable is about 5000 (Hefner, spherical). The 3000-c.p. lamp on 220 volts takes normally 2·7 amps. and consumes about 0·2 watts per Hefner candle. A regulating resistance of 18 ohms is used. J. S. D.

ALTERNATING CURRENTS AND MAGNETISM.

642. *The Wiedemann-effect in Pure Cobalt.* **H. A. Pidgeon.** (Phys. Rev. 13. pp. 209–237, March, 1919.)—Experimental curves are shown of the Wiedemann-effect in pure cobalt wires (99·73 and 98·71 % Co respectively), and for comparison, results are also given for iron and nickel subjected to the same heat treatment. In iron, the max. twist was 40·5 seconds per cm. in a longitudinal field of 14·1 c.g.s. when the specimen carried a current of 5·38 amps./mm.². All the iron curves gave zero twist for a field of approximately 250 c.g.s. With further increase in field, the twist after reaching a small max. negative value, tends to zero. In nickel the corresponding figures were: 190″ per cm. in a field of 21·2 c.g.s. with current 5·536 amps./mm.², and in cobalt: 27·7″ per cm. in a field of 75·8 c.g.s. with current 7·102 amps./mm.². In the less pure specimen, the values were 51·9″ per cm., 41·3 c.g.s., and 6·677 amps./mm.². Thus, the max. twist for the purer specimen is much less than for the other, and occurs at a higher value of the longitudinal field. These results do not agree with those of Honda and Shimizu [Abs. 165 (1904)], and the difference is put down to the degree of purity of the specimen. There is marked similarity in the results for nickel and cobalt. Further, it is a general characteristic of all three metals that the more thorough the annealing, the greater is the max. twist, the sharper the peaks of the curves, and the lower the values of the longitudinal fields in which they occur. This is ascribed to the effect of annealing on susceptibility; also lack of symmetry in twist is considered to be due to various combinations of the factors: imperfect demagnetisation; change in temperature of specimen due to heating effect of current in it; and the æolotropic structure of the specimen. Curves are given of hysteresis of twist and field, for the three metals. The hysteresis is greatest in cobalt. G. E. A.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

643. *A Law of Radioscopy.* **G. Mazérès.** (Archives d'Él. Medicale, 27. pp. 76–78, March, 1919.)—Let A and B be two points coincident upon the screen when the focus of the tube is at F_1. A diaphragm is placed so as to limit the area of the fluorescent patch on the screen, then in whatever manner the tube is displaced the fluorescent patch will move in a similar manner if the diaphragm moves with the tube. By this means any displacement of the focus becomes visible, as it were, upon the screen. A simple sketch makes it quite clear that under such conditions when the focus is moved in any horizontal direction the images of A and B separate, and, whatever may be the magnitude and direction of the displacement of the tube, the image which arrives first at the boundary of the fluorescent patch corresponds to the object farthest from the screen. By an application of this simple fact it is possible to examine a fractured limb without the usual turning about of the member. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

644. *Action of Penetrating Radium Rays on Colloids.* II. **A. Fernau and W. Pauli.** (Kolloid Zeits. 20. pp. 20–33, Jan., 1917.)—In the first paper (Biochem. Zeits. 70, pp. 426–441, 1915) it was found that radium rays precipitated electropositive inorganic colloids, but not electronegative; the effect was associated with a change in the viscosity. Organic suspensoids were agglutinated. This second paper deals particularly with colloidal solutions of ceric hydrate prepared by dialysis of ceric-ammonium nitrate. In this case the diminution of viscosity only sets in after a latent period; there is also a gradual loss of the faculty to gelatinise and a diminution of the sensitiveness to electrolytes, connected probably with a gradual dehydration of the sol. The action of β- and γ-rays modifies these effects, first further retarding the loss of viscosity, afterwards accelerating it. Electrolytes also affect the viscosity in these two stages, but the effects are distinguishable from the radiation effects; the jelly produced by the action of electrolytes is unstable, turns turbid and contracts under liberation of water. Chlorine ion is at once taken up by the sol from sodium chloride, and electrometrically there is no second stage. In the ageing by β- and γ-rays the viscosity-increase in the second stage is probably due to the aggregation of electrically neutral particles, which process takes place at the rate of a crystallisation. The phenomena are complex, but the changes in viscosity and internal friction in general are in accordance with the theory of the late M. v. Smoluchowski (Kolloid Zeits. 18. p. 190, 1916) who, starting from the Helmholtz double layer, limited his theory to suspensoids, however. H. B.

645. *Energy-change in Photochemical Processes.* VIII. *Photolysis of Aqueous Solutions and the Law of Photochemical Equivalence.* **E. Warburg.** (Preuss. Akad. Wiss. Berlin, Ber. 52. pp. 1228–1246, 1919. From the Physikal.-Techn. Reichsanstalt.)—The photolysis of aqueous solutions involving the determinations of the absorption of radiation has been investigated by Henri and Wurmser (1913) for hydrogen peroxide, by Boll (1914) for platino hydrochloric acid, by Vránek (1917) for potassium cobalt oxalate, and by Lasareff (1907) for cyanine, etc. The author investigates the conversion of potassium nitrate into nitrite, with special regard to Einstein's law of equivalence [see Abs. 879 (1918)]. The nitrite formed is determined by titration with potassium iodide; the radiations are emitted by sparks between zinc electrodes. The specific photochemical effect is found to be very much stronger in weakly-alkaline than in weakly-acid solutions. Slight changes in the alkalinity have little influence, but with stronger alkalinity (0·1N-NaOH added to 0·3N-KNO_3) some other, so far unidentified substance is formed by the photolysis—in addition to nitrite—which oxidises the KI. The results obtained are discussed with reference to K. Schäfer's researches on absorption of light by the nitrates of the alkalies and alkaline earths. Einstein's law does not hold. The author suggests in explanation that, in aqueous solutions, the whole energy-quantum absorbed need not become available for decomposition, but that part of the energy is taken over by neighbouring molecules before decomposition takes place. The specific photochemical effect decreases with increasing concentration. H. B.

646. *Effect of Rate of Temperature Change on Transformations in an Alloy Steel.* **H. Scott.** (Am. Inst. Mining Eng., Bull. No. 146. pp. 157–167, Feb., 1919.)—A steel containing 1·75 % C, 0·26 % Mn, 2·90 % Co, 15·0 % Cr was cooled down at varying rates from 920° C. With cooling velocities of less than 0·15 deg. C. per sec. the normal A*r*1 point was observed. When the velocity passed 0·70 deg. C. per sec. only the lowered point A*r*2 was registered, and between these critical values both the normal A*r* and the depressed A*r*2 were obtained. The A*r*1 point fell from 760° to 695° C. as the cooling velocity increased from zero to 0·7 deg. C. per sec., while that of the A*r*2 point fell from 440° to 370° C. in the range 0·15 deg. to 1·2 deg. C. per sec. The values for the rate of temperature change were reduced from the inverse rate curves taken on cooling midway between A*r*1 and A*r*2 and on heating just before A*c* 1–3 when the A*r*1 point is given, the structure consists of carbide and a pearlitic matrix. With both A*r*1 and A*r*2 a troostitic material is seen, and when A*r*2 only occurs the structure is martensitic. The heating curves of steels which on cooling showed A*r*2 give a point A*c*, the evolution of heat suppressed during the previous cooling, which is associated micrographically with the formation of troostite. The A*c*1–3 point lies on a smooth curve which is slightly higher, 10–15 deg. C., for the slowly cooled steels than for the quickly cooled, over the temperatures lying between 810° and 840° C.

F. C. T.

647. *Effect of Temperature, Deformation, and Grain Size on the Mechanical Properties of Metals.* **Z. Jeffries.** (Am. Inst. Mining Eng., Bull. No. 146. pp. 575–578, Feb., 1919.)—Consists of a summary of a paper dealing with the interpretation of the amorphous theory in metals. It is advocated that the properties of solid substances be studied from the number of constituents present, the quantity and arrangement of each constituent, and the properties of each constituent. Each deformable crystalline constituent will by plastic deformation produce amorphous material, thus changing its properties. The variations in properties of the amorphous and crystalline phases are dealt with and summarised as follows :—(1) The cohesion of the amorphous phase is substantially zero at the melting-point, while the cohesion of the crystalline phase is considerable at the melting-point. (2) The coefficient of expansion of the amorphous and crystalline phases of a substance, in general, should vary inversely as their cohesion. (3) If a non-allotropic metal is worked below its recrystallisation temperature, its elongation and tenacity increase below the temperature at which it was deformed, and decrease above it up to the recrystallisation temperature. (4) The rate of deformation of the amorphous phase with a given absolute cohesion is much less than that of the crystalline phase at a temperature of equal cohesion. (5) It is probable that the mobile state occurs while the amorphous phase is in the process of formation at the slip planes ; the mobile state is the one permitting a slip, and this generates amorphous material. (6) The mechanical properties of iron can be explained best by assuming that an allotropic change occurs between ordinary temperatures and 450° C. ; all the tensile properties of both annealed and cold-worked iron show discontinuities in this temperature range. (7) The mechanism of rupture is discussed. If a crystal breaks without deformation it is probable that no amorphous material is generated at the planes of fracture. Rupture takes place by degrees ; ductility favours this, and the reduction of area at the point of fracture is the result of it. The amorphous phase has the ability to flow like glass at relatively high temperatures, but, like glass, it is rigid and brittle at low temperatures. (8) The results of several hundred tensile tests on copper, tungsten, and iron at temperatures between — 190° and 1000° C. are discussed. (9) A note is given on the properties of complex alloys.

[See also Abs. 208 and 584 (1918).] C. O. B.

648. *The Tenacity of Basic Steel.* **A. McWilliam.** (Iron and Steel Inst., J., 1918. Engineering, 106. pp. 315–316, Sept. 20, 1918.)—The tensile strength of basic steel in its normal condition may be calculated from the formula: Max. load = 38,000 + [800 + 4 (C — 20)] C + 120 Si + [100 + 2 (*c* — 20)] Mn + 1000 P, lbs. per sq. in.; where C, Si, Mn, and P are the contents of carbon, Si, Mn, and phosphorus in the steel in units of 0·01 %. The formula applies to steel in the form of 1-in. round bars. F. C. T.

649. *The Allotropic Transformation of Nickel.* **Jänecke.** (Zeits. Elektrochem. 25. pp. 9–17, Jan., 1919. Engineering, 107. p. 326, March 7, 1919. Abstract.)—The allotropic transformation of nickel at about 350° is accompanied by a change in the dimensions which the author determines with the aid of a testing machine. The specimen, a cylinder 45 cm. in height, is placed between two plates, the lower one of which is fixed, and heated by an electric furnace surrounding it; the displacement of the upper plate by the expanding nickel can be determined within 0·007 mm. The expansion curve consisted of two straight lines meeting at about 350°; above that temperature the rate of expansion was more rapid. Between 347° and 356° (thermo-couple measurement) a jump of 0·01 mm. was observed, so that a rod of nickel, 5 m. long, would expand by about 1 mm. in passing from Ni *a* into Ni *β*. The method is recommended for the observation of gradual and sudden transformations. H. B.

650. *The Iron-Oxygen System.* **A. Smits** and **J. M. Bijvoet.** (K. Akad. Amsterdam, Proc. 21. 3. pp. 386–400, 1919.)—In the study of the three-phase equilibria of iron, its oxides and reducing gases, the systems FeO + Fe + G and Fe_3O_4 + Fe + G have been recognised. The question of the existence of a three-phase equilibrium $Fe_2O_3 + Fe_3O_4$ + G depends upon whether or not Fe_2O_3 and Fe_3O_4 form a continuous series of solid solutions as appeared likely from the conclusions of Sosman and Hostetter. Examination of their results on theoretical grounds indicates that while these oxides may be partially miscible in the solid state there is no reason to justify the conclusion that such a series is continuous, and it appears desirable to introduce the necessary equilibrium curve into the diagram. Three possible diagrams can then be drawn representing the equilibrium of iron and its oxides in contact with reducing gases. After adding to the selected diagram the equilibrium curve for the reaction $CO_2 + C \rightleftharpoons 2CO$, the conditions existing in the blast furnace are discussed theoretically. The oxygen pressures for the dissociation equilibria have been calculated for temperatures between 400° and 1000° C. and the results used in a partial plotting of the P-T diagram for the system Iron–Oxygen. F. C. A. H. L.

651. *Flaky and Woody Fractures in Nickel-Steel Gun Forgings.* **C. Y. Clayton, F. B. Foley,** and **F. B. Laney.** (Am. Inst. Mining Eng., Bull. No. 146. pp. 208–287, Feb., 1919.—Describes the results of an investigation of two forms of defect, namely, "flakes" or "snowflakes" and a "fibrous" or "woody" fracture frequently encountered in tensile test-bars of nickel steel. These defects appear most prominently in bars broken in a direction transverse to that of elongation in forging. In the case of woody fractures, foreign matter such as slag will occasionally be found to be present. In both woody and flaky specimens, phosphorus-etch mediums reveal a decidedly non-homogeneous structure. All flaky specimens examined gave indications of overheating, there being a lack of grain refinement. Only in a few cases was distinct segregation found, although tests showed that the flake areas were higher in phosphorus and carbon than the normal metal. During the testing of flaky metal small cracks were found to develop on the bar at right angles to the direction of stress. The effects of flakes on tests were loss of ductility, with corresponding decrease in reduction of area, and reduction of tensile strength and elasticity.

With regard to woody fractures, it is suggested that these are caused by the working of the original dendrites in the steel in parallel longitudinal lines by forging, accompanied by overheating. C. O. B.

652. *Observations on So-called "Flakes" in Steel.* **H. Styri.** (Chem. and Met. Eng. 20. pp. 342–351, April 1, 1919.)—Rejections of steel are from time to time experienced on account of low physical tests, especially elongation and reduction of area which are often associated with irregular spots, known by the name of flakes, in the fracture. These are noticed mostly in transverse test-bars of nickel steel, but are also found in other classes of steel. An ordinary chemical analysis does not indicate whether flakes are present or not. Further metallographic examination showed that different heat-treatments, and therefore microstructures, have no influence on the occurrence of flakes. These are shown to be due to slaggy particles in which no sign of nickel could be found and which were essentially silicates of Mn together with a little Fe. On dissolving the steel in acid, MnS and very limy silicates will go into solution. There was shown to be a striking general connection between the number of these slag inclusions and the elongation and reduction of area, but the elastic limit and max. stress did not seem to be affected. In all good test-bars, either no slag particles or only very small round ones were found. The tensile results from a single forging with 0·40 % C, 0·63 % Mn, 0·10 % Si, 0·55 % S, 0·031 % P, 2·88 % Ni, and 0·30 % Cr varied as a result of these slag inclusions between the following limits:—Elastic limits, 66,000–75,000 lbs. per sq. in.; max. stress, 99,500–107,500 lbs. per sq. in.; elongation, 11–22·5 %; reduction of area, 5·8–51·9 %. The presence of slag appears to have a pronounced influence upon the formation of cracks, these frequently passing through a string of small particles irrespective of grain boundaries, etc. Slag also exerts an influence in increasing corrosion, especially in acid solutions. The effect of slag inclusions in carbon steels is similar and is very harmful in connection with the formation of hardening cracks. The production of "fibre" in steel appears to be intimately connected with slag and sulphide strings. Other, though less common, causes of flaking include cracks formed as a result of faulty mill practice, by blow-holes, or segregation. Heat-treatment is in general powerless to cure flaking. F. C. T.

653. *Artificial Colouring of Liquid Crystals.* **P. Gaubert.** (Comptes Rendus, 167. pp. 1073–1075, Dec. 30, 1918.)—Indophenol is preferable for the colouring of liquid crystals to the substances previously used by Lehmann and by the author, because the solidified crystals are in many cases likewise coloured. The indophenol lowers the freezing-points of the molten substances and also the transformation points, and as only small quantities of

indophenol are required, Raoult's law is applicable. Optically-negative liquid crystals (cholesterin esters) show a deeper reddish colour in the direction of the optical axis, as they orient themselves vertically in the layer, than in other directions, whilst optically-positive crystals (anisolamino cinnamate) show a lighter colour; in both cases Babinet's absorption rule holds; polychroism is noticed in the mixture parallel to the plane. Liquid crystals of cholesterin compounds with glycerol, glycollic acid, etc., do not become coloured by indophenol; the isotropic liquid dissolves the indophenol, but as soon as liquid crystals form, the colouring matter is expelled. H. B.

654. *Dimensions of Molecules and Solubility.* **W. Herz.** (Zeits. Elektrochem. 23. pp. 23–24, Jan. 1, 1917.)—For particles of dimensions from 2 μ downward the solubility increases as the grains are made smaller. In liquids the size of the molecular particles cannot be altered, but for closely-related liquids such as the members of organic series the solubility should decrease as the molecular weight increases. Having previously shown (*ibid.* 21. p. 373) that in such series the molecular diameters vary as the molecular weights and increase with increasing number of carbon atoms, the author proves that in the case of alcohols and fatty acids the lower member is more soluble in water than the higher homologue. This holds also for methyl esters. Isomers should not have the same solubility, and it is indeed found that the solubility differences are smaller in the case of isomers which are closely related than in isomers further removed from one another. H. B.

655. *Relation between the Physical Properties of Solutions and of their Mixtures.* **E. Andersson.** (Nobel Inst. Meddel. 3. No. 12. pp. 1–22, 1916.)—Referring chiefly to Arrhenius and C. Bender, the author shows that the law of isohydric solutions—that the dissociation of two solutions containing one common ion in the same concentration is not altered on mixing the solutions—which holds for the specific conductivity of solutions of univalent elements, is applicable also to specific gravity, to specific electrolytic conductivity, surface tension, thermal expansion, and depression of the freezing-point, and to corresponding solutions, within limits. As regards the freezing-points of mixtures of salts and sugar, *e.g.*, the formula has to be modified. The experiments were made with chlorides, and sulphates of the alkali metals and of copper, also with other salts and sucrose. H. B.

656. *Forms assumed by Drops and Vortices of a Gelatinising Liquid in Various Coagulating Solutions.* **E. Hatschek.** (Roy. Soc., Proc. 95. pp. 303–316, Feb. 1, 1919.)—The author has studied the forms produced by gelatin sols when allowed to drop into liquids in which the gelatin is coagulated. When dropped into a solution of aluminium sulphate, or mixture of aluminium and ferrous sulphates of suitable density, a hanging drop can be realised, which shows, however, a more or less corrugated stem, owing to colloid shrinkage. Mushroom forms, similarly, are produced. When gelation is allowed to take place in a gum arabic sol, that is in the absence of salts, beautiful medusæ forms are obtained which show no ribs. When a gelatin sol to which potassium ferrocyanide has been added, is allowed to drop into a solution of copper sulphate, a semi-permeable membrane is formed around the gelatin sol. In such cases the drop flattens out into a disc bearing a striking resemblance to the human red blood corpuscle. Similar models of the red blood corpuscles are obtained by dropping gelatin sols into a solution of tannin, rendered sufficiently dense by the addition of cane sugar. Various

other forms can be obtained by adding lyotropic salts to the gelatin. By dropping a gelatin sol into a solution containing ferric chloride, whereby the gelatin drop is rapidly coagulated on the surface, water may diffuse into the still liquid gelatin sol and swelling of the drop take place. In this way the coating may be ruptured and segmentation occur. The results obtained by the author are of interest as giving rise to forms similar to those shown by organisms, etc. The marked effect of the conditions on the forms assumed by gelatin sols is strikingly analogous to the effects met with in organic nature. A. F.

657. *On the Significance of the Volta-effect in Measurements of Electromotive Equilibria.* **A. Smits** and **J. M. Bijvoet.** (K. Akad. Amsterdam, Proc. 21. 4. pp. 562–569, 1919.)—By application of the more recent views on the electromotive equilibria to the Volta-effect, the result was obtained that on polarisation and passivation the change in the Volta-effect must be great according to this theory, and that in these phenomena the Volta-effect would even constitute the greatest part of the total change in the e.m.f. It was further pointed out that if the Volta-effects between metals in which the state of internal equilibrium prevails, should be really very small—a behaviour on which opinion is still divided, but which recent experiments have rendered probable—this would have to be considered as a very characteristic property for metals in the state of internal equilibrium. In the present investigation the Volta-effect was taken into account, and the author has derived a number of relations in which the solubility product of the metal, the solubility quotient of the non-metal, or electron concentration in the electrolyte occurs. These expressions do not contain the Volta-effect, however, and enable us to draw up a solubility product series of metals, and a solubility quotient series of metalloids from which conclusions can be drawn about the chemical and electro-chemical behaviour of the elements. A. F.

658. *Combustion Galvanic Cells at High Temperatures.* **E. Baur, A[gnes] Petersen,** and **G. Füllemann.** (Zeits. Elektrochem. 22. pp. 409–414, Nov. 1, 1916.)—The experiments previously made with kathodes consisting of fused silver saturated with oxygen [Abs. 296 (1918)] were continued with copper oxides and other oxides which dissociate at the temperatures used, 600° to 1300° C. In some experiments CO was passed through the cell. The simplest form of cell was a crucible containing fused copper oxide into which rods of iron (or nickel) and of carbon dip. In order to prevent the attack of the iron by the copper oxide, the tubular iron electrode is provided, at its lower end, with a porcelain sheath, into which the fused oxide is sucked; thus contact between the iron and cooled oxide is ensured. On the copper oxide of the crucible float borax or silicates (glass) which become saturated with the cupric oxide or the cuprous oxide which forms about 1000°; the e.m.f. depends upon the oxide. In other combinations lead oxide and lead and, further, iron oxides were used, necessitating other expedients. The comparisons with the oxygen carbon cells are based on various authorities. The $CuO,Cu_2O|electrolyte|C$ combination yielded up to 1·4 volts at 1200°; the lead couples, 1·0 volt at 1200°; the Fe_3O_4, $FeO|CuO,Cu_2O$ 0·8 volt between 700 and 960°; $PbO,Pb|CuO,Cu_2O$ 0·44 volt at 990°; and $NiO,Ni|CuO,Cu_2O$ 0·717 volt at 860°. H. B.

659. *Oxygen Pressure of Some Oxides and the Carbon-Oxygen Cell at High Temperatures.* **W. D. Treadwell.** (Zeits. Elektrochem. 22. pp. 414–421, Nov. 1, 1916.)—In connection with the researches of Baur [see preceding Abs.] the author determined the oxygen pressures of the oxides mentioned by measuring their potentials against Baur's silver-oxygen electrode by a compensation method at temperatures between 800 and 1200°. The general arrangement was the same as that of Baur, but the author made use of a platinum-resistance furnace instead of the kryptol furnace of the former. The powdered oxides were mixed with borax, glass, or porcelain. The oxygen pressures found (partly by extrapolation) are: cupric oxide, 0·21 atmo. at 1008° and 1 atmo. at 1085°; cuprous oxide, 0·21 atmo. at 1693°; ferric oxide, 0·21 atmo. at 1322° and 1 atmo. at 1405°; lead oxide had no appreciable oxygen pressure about 1000°, at 1200° the pressure would be 0·014 mm. These values are deduced from potential measurements, and the paper is largely taken up with a discussion of the agreement between these data and the thermal data of various authorities. H. B.

660. *Electrical Supertension.* **A. Smits.** (K. Akad. Amsterdam, Proc. 21. 3. pp. 375–381, 1919.)—A theoretical paper in which it is shown that the supertension of hydrogen at a Pt electrode cannot be differentiated in any way from the phenomenon of kathodic polarisation. The supertension is simply a consequence of retardation in the establishment of the internal equilibrium in the electrode during the electrolytic separation of the hydrogen. Supertension in the case of evolution of other gases can be explained similarly. The setting-up of the internal equilibrium depends on the condition of the metal in the electrode; for example, it is set up very much more rapidly in a platinised than in a smooth Pt electrode, with the result that the supertension of hydrogen is practically zero with the former electrode. The electrolyte can also exert an influence on the establishment of this equilibrium. T. S. P.

661. *Periodic Passivity of Iron.* II. **A. Smits** and **C. A. L. de Bruyn.** (K. Akad. Amsterdam, Proc. 21. 3. pp. 382–385, 1919.)—A continuation of former experiments [see Abs. 331 (1917)], using solutions of ferrous sulphate (0·72 molar) in which the chloride ion (0·014 molar $FeCl_2$) has a smaller concentration than previously. The observed potential differences against the normal calomel electrode vary from −0·3 volt in the active state to +1·4 volts in the passive state, the corresponding current densities being respectively 33 and 28 milliamps. per cm.^{2}; the iron is passive for a much longer time than it is active and the periods (6·15 secs.) are very regular. With slightly smaller current densities, namely 30 and 25 milliamps. per cm.^{2}, the periods become longer, the active and passive states having about the same duration. Diminishing the current density still more does not give a stable periodicity in which the active state lasts longer than the passive state. When the ion anode is simply immersed in the electrolyte, and not sealed into the short leg of a U-shaped tube as in the above experiments, the periodic passivity, as explored by placing the auxiliary electrode at different heights of the iron electrode, varies with the depth below the liquid. At the bottom of the anode there is a regular periodicity, but with increasing heights towards the top of the electrode the periodicity becomes more and more irregular. It is also shown that the greater the surface of the iron anode the greater is the difficulty of making it passive. T. S. P.